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PROCEEDINGS

OF THE

Yorkshire Geological Society.

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1909—1911.

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ARTHUR R. DWERRYHOUSE, D.Sc., F.G.S.

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WILLIAM LOWER CARTER, M.A., F.G.S.

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Yours faithfully

Ripon

Proc. Yorks. Geol. Soc., Vol. XVII., Plate I.

Vol. XVII.] [Part I.

PROCEEDINGS
OF THE
YORKSHIRE GEOLOGICAL SOCIETY.

Edited by ARTHUR R. DWERRYHOUSE, D.Sc., F.G.S.

1909.

In Memoriam.

THE MARQUIS OF RIPON, K.G., G.C.S.I., LL.D., D.C.L., F.R.S.

On July 9th, 1909, in the eighty-second year of his age, and the fifty-first of his Presidency of our Society, the Marquis of Ripon passed away at his Yorkshire home, Studley Royal, deeply regretted by a world-wide circle, and by none more truly than by the great company of Yorkshiremen with whom he had laboured for the years of a long lifetime in divers efforts for the welfare of their county.

Of Lord Ripon's brilliant career in the service of the State it is not necessary to say much here. He occupied positions of the greatest eminence as the representative of Queen Victoria and as a member of several of her Governments, and completed his immense services to monarch and country by office in the second Parliament of King Edward VII.

Through this long and eminent career he won the regard of all those with whom he was associated as a man of large mind and sincere nature, a true lover of liberty, and full of sympathy with movements of reform. In disposition he was warm-hearted, generous, and kindly, and those who came into closest contact with him know best the perfect courtesy and lofty ideals of his soul. He was ever a lover of truth, and eminently fair-minded and liberal, and even those who were most bitterly opposed to some of the phases of his policy never accused him of being ignoble and self-seeking.

His connection with Yorkshire was close and continuous. He was seen at his best as the genial host of Studley Royal, displaying the venerable beauties of Fountains Abbey, in the preservation and elucidation of which he took so intense an interest. Here he entertained the present King, when Prince of Wales, in 1863, and subsequently had the satisfaction of welcoming Mr. W. E. Gladstone for three or four days in October, 1887. Nothing gave him greater pleasure than to throw open the Abbey with its delightful surroundings to the widest public, and to know of the deep appreciation with which this generosity was enjoyed.

Though much occupied by affairs of State, especially during his tenure of the Vice-Royalty of India, he neglected none of his local duties and responsibilities, and devoted much of his time to the advancement of education, county administration, and philanthropic work. His connection with the city of Ripon was intimate, and when, as the Mayor, he was presented with its freedom, his proud boast was that the people of Ripon regarded him as their friend. His work on the West Riding County Council, first as member and then as Chairman, was of the utmost value, and he took a notable part in the foundation of the Yorkshire College, and subsequently in its incorporation into the Victoria University. In 1882, on the death of Lord Frederick Cavendish, he became its President, and on the granting of a charter to the Leeds University he was the first Chancellor.

Lord Ripon's long connection with the Yorkshire Geological Society was no mere formality. His interest in its welfare was sincere. Whenever his public duties permitted he presided at its Annual Meetings, and gave many instructive and stimulating addresses on these occasions.

It was at the meeting of the Society's Council on November 12th, 1858, that the appointment of a successor to the late President, Earl Fitzwilliam, was considered. A resolution inviting Lord Ripon (then Viscount Goderich, M.P.) to accept the vacant position was given unanimously, and at the following meeting, held at Bradford on December 8th, 1858, he was installed as President, and for fifty-one years he maintained an unbroken interest in the Society over which he was thus called to preside.

On the occasion of his golden wedding in 1901 the Society presented Lord Ripon with an illuminated address signed by the officers and members of the Council. The last meeting at which his lordship was present was at Harrogate, on October 30th, 1902.

At the Annual Meeting of the Society at Doncaster, on November 12th, 1908, the following congratulatory telegram was forwarded to Studley Royal :—"The Yorkshire Geological Society, in Annual Meeting at Doncaster, congratulate your Lordship upon your fifty years' presidency, and gratefully acknowledge your services to the Society. You are elected for the fifty-first year."

The news of Lord Ripon's death was deeply regretted by the officers and Council, and they were represented at the funeral by Messrs. W. Lower Carter, M.A., F.G.S., and J. P. Simpson, J.P. So passed from our fellowship one whose love of truth and devotion to duty during a long life of varied public services have left a record of fidelity to ideals and an unswerving self-devotedness which will long be an inspiration to all who had the privilege of knowing him.

W. L. C.

CLASSIFIED LIST OF ORGANIC REMAINS FROM THE ROCKS OF THE EAST RIDING OF YORKSHIRE.

BY HENRY C. DRAKE, F.G.S., AND THOMAS SHEPPARD, F.G.S.

(*Read* 4th *March*, 1909; *Manuscript received 4th March*, 1909.)

This list has been compiled in order to aid future workers amongst the rocks of the East Riding by placing in a convenient and compact form all the various and scattered records that have been published. In addition, a number of species is now placed on record for the first time.

In the case of some of the beds which have been described, and from which lists of fossils have been published over and over again, the latest complete list in each instance has been recorded. In this way errors of former lists do not now find a place (unless the errors are indicated).

In the same way the question of nomenclature has to a large extent been simplified, as the more recent lists are usually the more up to date as regards the names. The present compilers have not, of course, attempted the almost hopeless task of endeavouring to give to each species recorded the name which, for the moment, is considered to be the correct one. Had this been done, many names in the following tables would only with difficulty be identified with those in the previously published lists.

By means of the following lists not only is it easy to ascertain whether a given species has been previously recorded for a given stratum, or in a given area, but a reference to the authority and the place of publication is also given.

By the "East Riding" the Parliamentary division is referred to, i.e., the area south of Filey ravine, south-east of York, and east of Selby.

It would be useful if similar lists were prepared for other divisions of the county.

The lists are given under the following heads, and at the beginning of each is a bibliography :—

1.—Post-glacial, including beds of silt, peat, and old lacustrine deposits, resting upon the Boulder Clay.

2.—Glacial, including boulder clay, the basement portion of which is fossiliferous ; the so-called "Bridlington Crag" ; the so-called "interglacial" gravels of Holderness ; and the deposits at Elloughton and Bielbecks.

3.—Pre-glacial, the deposits beneath the Boulder Clay at Hessle and Sewerby.

4.—The Upper Chalk of Flamborough Head and The Wolds.

5.—The Middle Chalk of Flamborough Head and The Wolds.

6.—The Lower Chalk at Speeton, Melton Bottoms, and in the railway cuttings near South Cave.

7.—The Red Chalk exposed at Speeton, Melton, Welton, and the South Cave railway cuttings.

8.—The Speeton Clay.

9.—The Portlandian of Judd at Speeton.

10.—The Kimeridge Clay at Speeton.

11.—The Corallian Rocks at Langton Wold, North Grimston, and Settrington.

12.—The Oxford Clay at South Cave.

13.—The Kellaways Rock in the cutting at South Cave.

14.—The Millepore Oolite at South Cave.

15.—The Lias (Upper, Middle, and Lower) exposed near Market Weighton and North and South Cave.

POST-GLACIAL.

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POST-GLACIAL.

NAME.	Hornsea.	Bridlington.	Skipsea.	Kelsey Hill.	Sand-le-Mere.	Holmpton.	Crome.	Withernsea.	Hull Docks. etc.	Other Localities and Remarks.
VERTEBRATA.										
Homo sapiens (man) ...	...	...	...	...	...	...	...	...	...	Kilnsea, 10.
Bos, sp.	...	...	...	...	4	...	...	...	...	Owthorne, 15.
,, *primigenius* (urus) ...	2, 14	...	...	...	...	...	12	2	...	Kilnsea, 14, 1903.
,, *longifrons*	...	...	...	...	...	...	12	10	...	
Cervus elaphus (red deer)	2, 11, 14	...	10	...	...	10	12	10	...	Barmston, 2, 15; Owthorne, 15.
,, *megaceros* (Irish elk)	2, 14	...	2, 4	...	...	...	...	...	...	
,, *tarandus* (reindeer) ...	...	...	...	...	...	...	...	...	10	
,, sp.	...	...	...	...	4	...	...	...	...	Owthorne, 15.
Equus caballus (horse) ...	...	...	...	...	...	...	12	10	...	
,, sp.	2	...	...	...	...	...	...	...	...	
Castor fiber (beaver) ...	...	...	...	...	...	...	12	...	...	Wawne, 10; Kilnsea 14.
[*Felis spelœa* (lion)... ...	2, 14	...	...	...	...	...	...	...	...	Recorded for Hornsea in error (see Bielbecks).]
Canis, sp.	...	...	...	...	...	...	12	10	...	
[*Elephas primigenius* (mammoth)	2, 14	...	...	...	...	...	...	...	...	York Museum, recorded in error.]
Aves, sp. (bird)	11	...	...	2	...	...	12	...	...	
Anas boscas, L. (duck) ...	...	...	...	...	...	...	...	10	...	
Perca fluviatilis (perch) ...	2, 11	...	...	...	2	...	...	...	...	
Esox lucius (pike)	14	...	...	...	...	...	...	...	...	Atwick, 2; Out Newton, 14, 1900.
Fish Scales	2, 11	...	...	...	...	...	...	...	...	

NAME	Hornsea.	Bridlington.	Skipsea.	Kelsey Hill.	Sand-le-Mere.	Holmpton.	Ulrome.	Withernsea.	Hull Docks etc.	Other Localities and Remarks.
INSECTA.										
Coleoptera	...	...	...	2	2	...	...	...	3	Filey, 17.
Donacia, sp....	11	...	...	2	...	...	...	...	...	
Gyrinus, sp.	...	...	...	2	...	...	...	...	...	
Pterostichus, sp.	11	...	...	...	...	...	...	...	...	
Agabus, sp.	11	...	...	...	...	...	...	...	...	
CRUSTACEA.										
Cypris, sp.	11	...	...	...	...	...	...	...	...	
,, *compressa*	2	...	...	...	...	...	...	...	...	
,, *gibba*	2	...	...	...	...	...	...	...	...	
,, *reptans*	2	...	...	...	...	...	...	...	...	
Cypridopsis obesa	2	...	...	...	...	...	...	...	...	
Candona detecta	2	...	...	...	...	...	...	...	...	
,, *albicans*	2	...	...	...	...	...	...	...	...	
,, *lactea*	2	...	...	...	...	...	...	...	...	
Limnicythere inoptina ...	2	...	...	...	...	...	...	...	...	
Cytheridea lacustris... ...	2	...	...	...	...	...	...	...	...	
Spongilla	11	...	...	...	...	...	...	...	...	
MOLLUSCA.										
Anodonta, sp.	2	5	...	...	...	...	...	...	...	
,, *cygnea*	11, 4, 2	...	7	...	...	...	...	...	...	Owthorne, 4; Mapleton, 7 (Unio) Hornsea, 11; Dimlington ? 11.

Anodonta anatina	2	...	...	...	2	...	...	...	...	
Bythinia, sp.	2	5	...	...	...	...	...	...	...	
,, *tentaculata* ...	11, 2, 7	13, 7	2, 4, 6, 7	...	...	2, 7	...	...	...	
,, *leachii*	...	...	6	...	...	...	...	...	...	
Bullina obtusa	...	...	...	...	...	...	...	...	2, 3	
Cochlicopa lubrica	...	13	...	...	...	...	...	...	...	
Cyclas, sp.	2	5	...	...	18	...	...	...	...	
,, *cornea*	2	...	2, 4	...	2	2	...	...	...	
,, *lacustris*	...	...	2, 4	...	...	...	...	...	...	
Limnœa, sp....	2	...	...	...	18	...	...	...	2, 3	
,, *peregra*	11,2,7,9	5,13,2,7	6, 7	...	...	2, 7	7	...	...	Dimlington, 7; Mapleton and Atwick, 7.
,, *palustris*	...	13, 7	...	...	...	...	...	...	...	
,, *auricularia* ...	11, 7, 9	...	...	...	...	...	...	...	...	
,, *truncatulata* ...	11, 7	13, 7	...	...	...	...	...	...	...	
,, *stagnalis*	...	7, 4, 2	2, 6, 7	...	...	7	...	...	...	Withernsea, 2; Nevill's Dyke, 7; Atwick, 7.
Pisidium fontinale	11, 9	...	7, 6	...	...	...	...	...	...	
,, *pusillum*	2, 11	13	6, 7	...	2	2, 7	7	...	...	South of Withernsea, 7; Kilnsea, 7; Atwick, Easington, Nevill's Dyke, Mapleton, 7.
,, *nitidum*	11	...	...	...	...	...	...	...	...	
,, *milium*	11	...	...	...	...	...	...	...	...	
,, *peregra*	2	...	...	...	...	...	...	...	...	
,, *roseum*	...	...	6, 7	...	...	...	...	...	...	
,, sp.	2	...	5	...	...	...	...	...	...	
Planorbis albus	11	...	7	...	...	...	...	...	...	
,, *nautileus*	11, 2	...	7	...	...	...	...	...	...	Mapleton and Atwick, 7.
,, *parvus*	11	...	...	...	...	...	...	...	...	
,, *spirorbis*	11	13	...	...	...	...	...	...	...	

NAME.	Hornsea.	Bridlington.	Skipsea.	Kelsey Hill.	Sand-le-Mere.	Holmpton.	Ulrome.	Withernsea.	Hull Docks, etc.	Other Localities and Remarks.
Planorbis vortex	11	...	...	...	...	...	...	...	...	
,, *umbilicatus* ...	11	13	7	...	...	...	...	...	...	Mapleton and Atwick, 7.
,, *contortus*	11, 2	...	7	...	...	...	...	...	...	
,, *glaber*	11	...	...	...	...	...	...	...	...	
,, *fontanus*	...	...	7	...	...	...	...	...	...	
,, *carinatus*	...	13	...	...	...	...	...	...	...	
,, sp.	2	5	...	...	18	2	...	...	2, 3	
Helix pulchella	11	...	...	...	...	...	...	...	...	Sewerby.
,, *hispida*	11	...	...	...	...	...	...	...	...	
Segmentina nitida	11	...	...	...	...	...	...	...	...	
Sphærium corneum	11, 4, 2	13, 4	7, 6, 42	...	...	...	...	...	...	Dimlington, 11; Nevill's Dyke, Mapleton, Atwick Gap, and Atwick, 7.
Succinia putris	11	13	...	...	...	...	...	...	...	Nevill's Dyke, 7.
Valvata piscinalis	...	...	6, 7	...	...	...	...	...	...	
,, ,, var. *antiqua*	11	...	...	...	2	...	...	...	...	
,, *fluviatilis*	2	...	...	...	...	...	...	...	...	
,, *cristata*	11	...	6, 7	...	2	...	...	...	...	
Pupa muscorum	11	...	...	...	...	...	...	...	...	Sewerby Cliff, 13, 7.
Cardium edule	...	...	...	...	18	...	...	...	2, 3, 16	
Hydrobia, sp.	...	...	...	...	18	...	...	...	2, 3	
,, *ulvæ*	...	...	...	...	...	...	...	...	2, 3	
Littorina littorea	...	...	...	...	...	...	...	...	2, 3, 16	

Tellina balthica	...	...	...	...	18	...	...	...	2, 3, 16	
,, *solidula*	...	...	...	...	...	...	...	...	2, 3	
Scrobicularia piperata ...	...	...	...	...	18	...	...	...	2, 3, 16	
,, *plana*	...	...	...	...	...	...	...	...	2, 3, 16	
Mytilus edulis	...	...	...	...	18	...	...	...	...	
PLANTÆ.										
Pinus sylvestris	2	...	...	...	...	...	...	...	2, 3	and near Burton Pidsea, 10.
Alnus glutinosa	2	...	...	...	2	...	...	...	...	
Quercus robur	2	...	...	...	2	...	...	...	2, 3	
Salix, sp.	2, 11	...	...	...	2	...	...	...	...	Filey, 17.
Prunus padus	2	...	...	...	2	...	...	...	...	
Corylus avellana	...	...	...	...	2	...	...	...	2, 3	and near Burton Pidsea, 10; Filey 17
Betula nana	...	5	...	...	...	2	...	...	...	
Juncus, sp.	...	...	...	...	2	...	...	...	...	
Carex, sp.	11	...	...	...	2	...	...	...	...	
Potamogeton, sp.	11, 2	5	...	...	2	...	...	...	...	
,, cf *natans* ...	11	...	...	...	...	...	...	...	...	
Viola palustris	11	...	...	...	...	...	...	...	...	
Hippuris vulgaris	11	...	...	...	...	...	...	...	...	
Potentilla, sp.	11	...	...	...	...	...	...	...	...	
Ranunculus, sp.	11	...	...	...	...	...	...	...	...	
Myriophyllum ?	...	5	...	...	...	...	...	...	...	
Hottonia, sp. ?	...	5	...	...	...	...	...	...	...	
Chara, sp.	11, 2	...	...	2	...	...	...	...	...	
Polytrichum commune ...	...	...	...	...	...	...	...	...	...	Filey, 17.
Sphagnum acutifolium ...	...	...	...	...	...	...	...	..	...	Filey, 17.
,, sp.	...	...	...	...	...	...	...	...	...	Filey, 17.
Musci	...	...	...	...	...	...	...	...	2, 3	

NAME	Hornsea.	Bridlington.	Skipsea.	Kelsey Hill.	Sand-le-Mere	Holmpton.	Ulrome.	Withernsea.	Hull Docks. etc.	Other Localities and Remarks.
DIATOMACEÆ.										
Cymbella ehrenbergii ...	1	1	...	...	...	...	...	...	...	
Mastogloia grevillei ...	1	...	...	...	...	...	...	...	...	
Stauroneis acuta	1	...	...	...	...	...	...	...	...	
,, *anceps* var. *amphicephala*	...	...	...	...	...	...	...	...	...	Marton, 1.
Pinnularia nobilis	1	...	...	...	...	...	...	...	...	
,, *major*	1	...	...	...	...	...	...	...	...	
,, *cardinalis* ...	1	...	...	...	...	...	...	...	...	
,, *nodosa*	...	...	...	...	...	...	...	...	...	Marton, 1.
,, *claviculus* ...	...	...	...	...	...	...	...	...	...	Marton, 1.
,, *acrosphæria ?* ...	...	..	...	...	...	...	...	...	...	Filey, 17.
Navicula oblonga	1	...	...	...	...	...	...	...	...	
,, *semen*	1	...	...	...	...	...	...	...	...	
,, *elliptica*	1	...	...	...	...	...	...	...	...	
,, *tuscula*	1	...	...	...	...	...	...	1	...	
,, *cuspidata*	1	...	...	...	...	...	...	...	...	
,, ,, *forma craticula* ...	...	...	...	...	...	...	...	...	...	Marton, 1.
,, *ambigua*	1	...	...	...	...	...	...	...	...	Marton, 1.
,, *sphærophora* ...	1	...	...	...	...	...	...	...	...	
,, *latiuscula* ...	1	...	...	...	...	...	...	...	...	
,, *iridis*, var. *amphirhynchus* ...	1	...	...	...	...	...	...	...	...	
,, *affinis*	1	...	...	...	...	...	...	...	...	
,, *bacillum*	1	...	...	...	...	...	...	...	...	
,, *lævissima* ...	1	...	...	...	...	...	...	...	...	
Schizonema smithii	1	...	...	...	...	...	...	...	...	
,, *grevillei* ...	...	...	...	...	1	...	...	...	...	

Pleurosigma attenuatum ...	1	...	...	...	...	...	...	...	...	
,, *spenceri,* var. *smithii* ...	1	...	...	...	...	...	...	...	...	
Gomphonema subtile ...	1	...	...	...	...	...	...	...	...	
Cocconeis molesta var. *amygdalina*	1	...	...	...	...	...	...	...	...	
Epithema turgida	1	...	...	...	...	...	...	...	...	
,, ,, var. *granulata* ...	1	...	...	...	...	...	...	...	...	
,, *hyndmani* ...	1	...	...	...	...	...	...	...	...	
,, *gibba* var. *ventricosa*	1	...	...	...	...	...	...	...	...	
,, *argus*	1	...	...	...	...	...	...	...	...	
,, ,, var. *longicornis* ...	1	...	...	...	...	...	...	...	...	
,, *nebra*	1	...	...	...	...	...	...	...	...	
,, ,, var. *proboscidea*	1	...	...	...	...	...	...	...	...	
,, *occellata*	1	...	...	...	...	...	...	...	...	
Eunotia robusta	...	1	...	...	...	...	...	...	...	
,, ,, var. *tetraodon* ...	...	1	...	...	...	...	...	...	...	
Synedra ulna	1	...	...	...	...	...	...	...	...	Filey, 17.
,, *capita*	1	...	...	...	...	...	...	...	...	
Fragilaria harrisonii ...	1	...	...	...	...	...	...	...	...	
Surirella elegans	1	...	...	...	...	...	...	...	...	
,, *ovalis*	1	...	...	...	...	...	...	...	...	
,, ,, var. *brightwelli* ...	1	...	...	...	...	...	...	...	...	
,, ,, var. *primata*	1	...	...	...	...	...	...	...	...	
Nitzschia punctata var. *elongata*...	1	...	...	...	...	...	...	...	...	
,, *tryblionella* var. *levidensis*	1	...	...	...	...	...	...	...	...	
,, *scalaris*	...	...	...	...	...	...	...	...	...	Marton, 1.
,, *vermicularis* ...	...	...	...	...	...	...	...	...	...	Marton, 1.

NAME.	Hornsea.	Bridlington.	Skipsea.	Kelsey Hill.	Sand-le-Mere.	Holmpton.	Ulrome.	Withernsea.	Hull Docks. etc.	Other Localities and Remarks.
Melosira roseana	—	...	...	...	...	...	...	...	...	
,, *arenaria*	—	...	...	...	...	...	...	...	...	
,, *granulata*	—	...	...	...	...	...	...	...	...	
Cyclotella antiqua	—	...	...	...	...	...	...	...	...	
Amphitetras antediluviana...	...	...	...	...	...	...	...	...	—	
Coscinodiscus oculus iridis ...	...	...	...	...	...	...	...	...	—	
DESMIDÆ.										
Calocylindrus palangula ...	...	...	...	...	...	...	...	...	...	Filey, 17.
,, var. *de baryi*...	...	...	...	...	...	...	...	...	...	Filey, 17.
Cylindrocystis diplospora (?)	...	...	...	...	...	...	...	...	...	Filey, 17.
Conferva, sp.	...	...	...	...	...	...	...	...	...	Filey, 17.
Penium brebissonii... ...	...	...	...	...	...	...	...	...	...	Filey, 17.
,, *truncatum*	...	...	...	...	...	...	...	...	...	Filey, 17.
,, sp.	...	...	...	...	...	...	...	...	...	Filey, 17.
Cosmarium homalodermum...	...	...	...	...	...	...	...	...	...	Filey, 17.
,, *globosum?* ...	...	...	...	...	...	...	...	...	...	Filey, 17.
,, *crenatum* ...	...	...	...	...	...	...	...	...	...	Filey, 17.
,, *undulatum* ...	...	...	...	...	...	...	...	...	...	Filey, 17.
,, *obliquum* (?) ...	...	...	...	...	...	...	...	...	...	Filey, 17.
OTHER ALGÆ.										
Merismopedia glauca ...	...	...	...	...	...	...	...	...	...	Filey, 17.
Oscillaria, sp.	...	...	...	...	...	...	...	...	...	Filey, 17.
Conferva tenerrima	...	...	...	...	...	...	...	...	...	Filey, 17.
Aphanocepsa, sp.	...	...	...	...	...	...	...	...	...	Filey, 17.
Aphenotheca ? sp.	...	...	...	...	...	...	...	...	...	Filey, 17.

GLACIAL.

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(See also Kendall and Lydekker, in "Victoria History of Yorkshire," Vol. 1.)

NAME.	Kelsey Hill.	Burstwick.	Brandesburton.	Elloughton.	Bielbecks.	Other Localities.
VERTEBRATA.						
Elephas primigenius (mammoth)	1	8, 10	1	9, 10	7	Hessle and all along the coast, 9; Middleton, 6; Pocklington, 6.
,, *antiquus*	...	...	...	9, 10	...	
,, sp. ?	...	...	...	...	15	
Cervus tarandus (reindeer)	1	...	...	9, 10	...	
,, *megaceros* (Irish "elk")	...	8, 10	...	...	7	
,, *elaphus* (red deer)	...	8, 10	...	...	9	
,, sp.	...	...	...	...	15	Pocklington, 6.
Bison priscus	1, 9	9	...	9, 10	7	
Bos primigenius	...	8, 10	...	9, 10	9, 15	Middleton, 6.
,, *taurus* (ox)	...	8, 10	...	...	...	
,, sp. ?	...	...	...	...	15	
Equus caballus (horse)	...	...	...	9, 10	9	Settrington, 6.
,, sp. ?	...	...	...	...	7	
Rhinoceros leptorhinus	1	...	...	...	...	
,, *tichorhinus* (=*antiquitatis*)	...	...	...	...	7	Dimlington, 9.
,, sp. ?	...	...	...	...	9	
Felis spelæa (lion)	...	...	...	...	7, 9	
Canis lupus (wolf)	...	...	...	...	7	
Hyæna sp.	...	10	...	...	...	
Trichechus rosmarus (walrus)	1, 9	...	...	...	...	
INSECTA (Coleoptera).						
Chrysoniela sp.	...	...	...	...	7	
Donacia sp. ?	...	...	...	...	15	
Hister sp. ?	...	...	...	...	15	

MOLLUSCA.						
Limnæa peregra	...	...	...	...	15	
,, *palustris*	...	...	...	...	15	
,, *truncatula*	...	...	...	...	15	
Succinea putris	...	...	...	...	15	
,, *elegans*	...	...	...	...	15	
Hyalinia nitidula	...	...	...	...	15	
Zonites fulvus	...	...	...	...	15	
Helix nemoralis	...	...	...	...	15	
,, *hispida* var. *concinna*	...	...	...	...	15	
,, *pygmæa*	...	...	...	...	15	
,, *pulchella*	...	...	...	...	15	
Vertigo antivertigo	...	...	...	...	15	
,, *pygmæa*	...	...	...	...	15	
Cochlicopa lubrica	...	...	...	...	15	
Carychium minimum	...	...	...	...	15	
Pisidium amnicum	...	...	...	...	15	
,, *pusillum*	...	...	...	...	15	
,, *nitidum*	...	...	...	...	15	
,, *milium*	...	...	...	...	15	
,, *obtusale*	...	...	...	...	15	
Bythinia tentaculata	...	...	...	...	15	
Valvata cristata	...	...	...	...	15	
Planorbis spirorbis	...	...	...	...	15	
,, *contortus*	...	...	...	...	15	
,, *glaber*	...	...	...	...	15	
,, *marginatus*	...	...	...	...	15	
PLANTÆ.						
Ranunculus sceleratus	...	...	...	...	15	
,, *repens*	...	...	...	...	15	
Viola sp.	...	...	...	...	15	
Œnanthe aquatica	...	...	...	...	15	
Rumex	...	...	...	...	15	
Sparganium erectum ?	...	...	...	...	15	
Carex	...	...	...	...	15	
Alisma plantago	...	...	...	...	15	
Potamogeton sp.	...	...	...	...	...	Bridlington, 1, 5.

NAME.	Bridlington.	Dimlington.	Kelsey Hill.	Burstwick.	Other Localities.
VERTEBRATA.					
(Probably those at Bridlington and Dimlington are derived from Crag, Eocene, or older Rocks).					
Carcharodon (teeth), and other sharks	1, 3	...	...	...	
Chrysophrys (teeth)	1, 3	...	...	...	
Lamna subulata, Ag. (teeth)	1	...	...	...	
,, sp.	1, 3	...	...	...	
Myliobatis (teeth)	1, 3	...	...	...	
Notidamus microdon, Ag. (teeth)	1, 3	...	...	...	
Oxyrhina (teeth)	1, 3	...	...	...	
Platax woodwardi ? Ag.	1, 3	...	...	...	
Raia batis, Mont. (teeth)	1, 3	...	...	...	
Otoliths of Gadoid fish	1, 3	...	...	...	
Fish vertebræ	1, 3	...	1, 9	...	
Plesiosaurus	1	...	...	...	
Ruminant, fragment of tooth	1, 3	...	...	...	
Ursus arctos	1, 13, 9	...	...	...	
ECHINODERMATA.					
Undetermined spines, &c.	3, 1, 4	1	2	...	
Echinocardium (Amphidetus) cordatus, Penn.	6	...	...	...	
Strongylocentrotus drobachiensis, Müller	6	...	...	...	

CRUSTACEA.					
Chela of crab	...	...	2	...	
CIRRIPEDIA.					
Balanus crenatus, Brug.	3, 1	1	1	8	1 Barf Hill.
,, *hameri*, Asc.	3, 1	1	1	...	1 Barf Hill.
,, *porcatus*, da'C.	3, 1	1	2, 1	...	5 Kelk, 1 Barf Hill.
Verruca strömia, Müll.	3, 1	...	...	...	
ENTOMOSTRACA.					
Cythere angulata, G. O. Sars	4, 1	...	...	...	
,, *concinna*, Jones	3, 1, 4	1	...	...	
,, *costata*, Brady	4, 1	...	...	...	
,, *cribrosa*, B., C. & R.	4, 1	...	...	...	
,, *dunelmensis*, Norman	3, 4, 1	1	...	...	
,, *emarginata*, G. O. Sars	4, 1	...	...	...	
,, *fimbriata*, Norman	4, 1	1	...	...	
,, *globulifera*, Brady	4, 1	...	...	...	
,, *jonesii*, Baird, var. *ceratoptera*	...	1	...	...	
,, *leioderma*, Norman	4, 1	...	...	...	
,, *mc chesneyi*, B. & C.	4, 1	...	...	...	
,, *mirabilis*, Brady	3, 4, 1	...	...	...	
,, *tuberculata*, G. O. Sars	3, 4, 1	1	...	...	
,, *villosa*, G. O. Sars	3, 4, 1	...	...	...	
Cytheridea elongata, Brady	3, 4, 1	...	...	...	
,, *papillosa*, Bosquet	4, 1	...	...	...	
,, *punctillata*, Brady	4, 1	1	...	...	
,, *sorbyana*, Jones	3, 4, 1	1	...	...	
Cytheropteron angulatum, B. & R.	4, 1	...	...	...	
,, *latissimum*, Norman	3, 4, 1	1	...	...	
,, *nodosum*, Brady	4, 1	...	...	...	
Cytherura clathrata, G. O. Sars	4, 1	...	...	...	
Eucythere argus, G. O. Sars	3, 4, 1	...	...	...	
Krithe glacialis, B., C. & R.	3, 4, 1	1	...	...	
Paradoxostoma ensiforme, Brady	4, 1	...	...	...	
,, *pyriforme*, B., C. & R.	4, 1	...	...	...	
Sclerochilus contortus, Norman	4, 1	...	...	...	

NAME.	Bridlington.	Dimlington.	Kelsey Hill.	Burstwick.	Other Localities.
POLYZOA.					
Undetermined	4, 1	...	...	...	
An Escharoid Polyzoan	...	...	2	...	
BRACHIOPODA.					
Crania sp.	...	...	...	...	5 Kelk.
Rhynchonella psittacea, Chemn.	3, 5, 1, 7	...	...	...	
Terebratula caput-serpentis	...	...	2	...	
LAMELLIBRANCHIATA.					
Anomia ephippium, L.	3, 1, 5, 7	1	2, 1	...	
,, ,, var. *aculeata*	3, 1, 5	...	...	...	
,, ,, var. *squamula*	3, 1, 5	...	...	...	
Astarte borealis, Chemn.	3, 5, 1, 7	1	1	8	5 Kelk, 1 Barf Hill.
,, ,, var. *mutabile*	3, 5, 1, 7	...	...	...	
,, ,, var. *whithami*	3, 5, 1, 7	1	...	...	
,, *compressa*, Mont.	3, 5, 1, 7	1	2, 1	...	
,, ,, var. *striata*	5, 1	...	...	...	
,, *depressa*, Brown	5, 1	1	...	...	
,, *sulcata*, da'C.	3, 5, 1, 7	...	...	...	
,, ,, var. *elliptica*	3, 5, 1, 7	1	...	...	
Axinopsis orbiculata, G. O. Sars	3, 5, 1	...	...	...	
Cardita borealis, Conrad = *Cyclocardia borealis*	3, 5, 1, 7	...	2	...	
Cardium echinatum, L.	...	?	...	...	
,, *edule*, L.	5, 7, 1	1	2, 1	8	5 Kelk, 1 Barf Hill.
,, *grœnlandicum*, Chemn.	3, 5, 1	1	...	...	

Cardium islandicum, L.	3, 5, 1, 7	1	...	...	
,, *exiguum*, Gmel.	...	...	1	...	1 Barf Hill, Burshall.
Corbula gibba, Olivi.	3, 5, 1, 7	...	1	...	
,, *pusilla*, Philippi.	3, 5, 1	...	...	...	
Crenella decussata, Mont.	3, 5, 1	...	...	...	
Cyprina islandica, L.	3, 5, 1, 7	1	1	8	5 Brandesburton, etc., Kelk, Kilham, and Keyingham.
Cyrena (Corbicula) fluminalis, Müll.	...	...	1	8	
Donax vittatus, da'C.	5, 7, 1	...	1	...	
Leda intermedia, M. Sars	3, 5, 1	...	...	...	
,, *lenticula*, Möll.	3, 5, 1	...	...	...	
,, *limatula*, Say.	3, 5, 1, 7	...	...	...	
,, *minuta*, Müll.	3, 5, 1, 7	...	...	...	
,, ,, var. *buccata*	5, 1, 7	...	...	...	
,, *pernula*, Müll.	5, 1	1	...	...	
,, *tenuis*	3, 5, 1	...	...	...	
Lutraria elliptica, Lam.	...	...	...	...	
Mactra solida, L., var. *elliptica*	3, 5, 1, 7	1	1	8	
,, *subtruncata*, da'C.	...	...	1	8	
,, *ovata*	...	...	...	...	5 Kelk.
,, *ovalis*	...	...	...	...	1 Barf Hill.
Montacuta dawsoni, Jeffreys	3, 1, 5, 7	...	...	...	
Mya arenaria, L.	5, ? 7	...	...	...	
,, *truncata*, L.	3, 5, 1, 7	1	1	8	5 Kelk, Nafferton, Barf Hill.
,, ,, var. *uddevallensis*	3, 5, 1	...	...	...	
Mytilus edulis, L.	3, 1, 5, 7	...	1	8	5 Kilham, Nafferton.
,, *modiolus*, L.	5, 1, 7	1	...	...	
Nucula cobboldiæ, Leathes	3, 1, 5, 7	1	...	...	
,, *tenuis*, Mont.	5, 1, 7	...	...	...	
,, ,, var. *inflata*	5, 1	...	...	...	
,, *nucleus*, L.	3, 1, 5	...	1	...	
Pecten islandicus, Müller	3, 1, 5, 7	1	1	...	
,, *opercularis*, L.	3, 1, 5	...	...	...	
,, *pes-lutræ*, L.	3,1, 5	...	...	...	
Pectunculus glycymeris, L.	3, 1, 5, 7	...	...	...	
Pholas crispata, L.	3, 1, 5, 7	1	1, 2	8	5 Kelk, 1 Barf Hill.

NAME.	Bridlington.	Dimlington.	Kelsey Hill.	Burstwick.	Other Localities.
Saxicava norvegica, Spengler	5, 1, 7	1	...	...	
,, *rugosa*, L.	5, 1, 7	1	...	...	
,, *arctica*, L.	...	...	1	...	
Solen ensis, L.	3, 5	...	...	...	
,, *siliqua* ? L.	...	...	1	...	
Tellina balthica, L.	3, 1, 5, 7	1	1, 2	8	5 Kelk, Kilham, Nafferton, 1 Barf Hill.
,, *calcaria*, Chemn.	3, 5, 1, 7	1	...	...	
,, *obliqua*, J. Sow.	5, 1	1	1	...	
,, *pusilla*, Philippi	3, 1, 5	...	...	...	
Tapes decussata, L.	...	...	1	8	
Thracia prætenuis, Pult.	5, 1, 7	...	...	...	
,, *pubescens*, Pult.	5, 1	1	...	...	
Venus fluctuosa, Gould	5, 1, 7	...	...	...	5 Kelk.
,, *gallina*, L.	...	...	1	...	1 Barf Hill.
,, *ovata*, Pennant	3, 1, 5	...	...	...	
Ostrea edulis, L.	...	...	1	8	5 Kelk, 1 Barf Hill.
Scrobicularia plana, da C.	...	...	1	...	
SOLENOCONCHIA.					
Dentalium entalis, L.	3, 1, 7	1	1	8	5 Kelk, 1 Barf Hill.
,, *striolatum*, Stimpson	3, 1, 7	1	...	...	
GASTEROPODA.					
***Admete viridula*, Fabr.**	**3, 1, 5, 7**	...	...	...	
***Amaura sulcosa*, Leche**	**3, 1, 5**	...	...	...	

Bela turricula, Mont. } = *Pleurotoma*	...	...	2	...	
,, *pyramidalis*, Str. }	...	...	2	...	
Buccinum grœnlandicum, Chemn.	3, 1, 5	...	...	...	
,, *undatum*, L.	3, 1, 5, 7	1	1, 2	8	5 Kelk. 1 Barf Hill.
Bulla crebristriata, Jeffr.	3, 1, 5	...	...	...	
Bittium reticulatum	...	...	2	...	
Columbella rosacea, Gould	5, 1, 7	...	...	...	
Cylichna alba, Brown	3, 1, 5	...	...	...	
,, *sculpta*, Leche	3, 1, 5	...	...	...	
Fusus curtus, Jeffr.	3, 1, 5, 7	...	...	...	
,, ,, var. *expansa*	7, 1, 5	...	...	...	
,, *despectus*, L.	3, 1, 5, 7	1	...	...	
,, *kroyeri*, Möll.	3, 1, 5	...	...	...	
,, *leckenbyi*, S. V. Wood	5, 1, 7	...	...	...	
,, *propinquus*, Alder	5, 1, 7	...	...	...	
,, *sarsi*, Jeffr.	5, 1, 7	...	...	...	
,, *spitzbergensis*, Reeve	5, 1, 7	1	...	...	
Gibbula cineraria, L.	...	...	2	...	
Hydrobia ulvæ, Pen.	...	...	2	...	
Lacuna divaricata, Fabr. = *Epheria divaricata*	3, 1, 5	...	2	...	
,, *crassior*, Mont.	...	...	1	...	
Lepeta cœca, Müll.	5, 1, 7	...	...	...	
Hima incrassata, Müll.	...	...	2	...	
Littorina globosa, Jeffr.	3, 1, 5	...	2	...	
,, *littorea*, L.	3, 1, 5, 7	1	1	8	
,, *obtusata*, L.	3, 1, 5	...	...	...	
,, ,, var.	3, 1, 5	...	...	...	
,, *squalida*, B. & S.	...	...	1	...	
,, *rudis*, Maton.	3, 1, 5, 7	...	1	...	
Murex erinaceus, L.	...	...	1	...	
Menestho albula, Fab.	3, 1, 5	...	...	...	
Nassa reticulata, L.	...	...	1	8	
Natica affinis, Gmel.	3, 1, 5, 7	1	...	...	
,, ,, var. *occlusa*	5, 1	...	...	...	
,, *alderi*, Forbes	...	...	1	...	
,, *catena*, da'C.	...	...	1	...	
,, *grœnlandica*, Beck	3, 1,5, 7	...	1	...	

NAME.	Bridlington.	Dimlington.	Kelsey Hill.	Burstwick.	Other Localities.
Natica lactea, Goulding	...	...	2	...	
,, *islandica*, Gmel.	3, 1, 5, 7	1	1	...	
,, *clausa*, B. & S.	...	...	2, 1	8	
,, *montacuti*, Forbes	5, 7, 1	...	...	...	
Odostomia conspicua, Alder	3, 5, 1	...	...	...	
Paludestrina ulvæ, Pen.	...	...	2	...	
Pleurotoma bicarinata, Couth.	3, 5, 1	...	...	...	
,, ,, var. *violacea*	3, 5, 1, 7	...	...	...	
,, *decussata*, Couth.	3, 5, 1	...	...	...	
,, ,, var.	5, 1	...	...	...	
,, *elegans*, Möll.	3, 5, 1, 7	...	...	...	
,, *exarata*, Möll.	3, 5, 1, 7	...	...	...	
,, *harpularia*, Couth.	5, 7, 1	...	...	...	
,, *multistriata*, Jeffr.	3, 5, 1	...	...	...	
,, *nebula*, Mont.	...	...	1	...	
,, *pyramidalis*, Str.	5, 7, 1	1	1, 2	...	
,, *simplex*, Midd.	3, 1, 5	...	...	...	
,, *trevelyana*, Turt.	5, 1, 7	...	...	...	
,, *turricula*, Mont.	3, 1, 5, 7	1	1, 2	8	
,, ,, var. *dowsoni*	5, 1	...	...	...	
Patella vulgata, L.	...	...	2	...	
Puncturella noachina, L.	3, 1, 5, 7	...	...	...	
Purpura lapillus, L.	3, 1, 5, 7	...	1, 2	8	5 Kelk, 1 Barf Hill.
Retusa obtusa, Mont.	...	...	2	...	
Rissoa subperforata, Jeffr.	3, 5, 1	...	...	...	
,, *striata*, Adams	3	...	...	...	
,, *semistriata*, Mont.	3	...	...	...	
,, *parva*, da'Costa, and var. *interrupta*	3, 1, 5	...	...	...	
,, *costata*, Adams	3	...	...	...	
,, *wyville-thomsoni*, Jeffr.	3, 1, 5	...	...	...	

Rissoa wyville-thomsoni, var.	1, 5	...	...	...	
,, *labiosa*, Mont.	...	...	1	...	
Scalaria grœnlandica, Chemn.	3, 1, 5, 7	1	...	8	
Trichotropis borealis, B. & S.	3, 1, 5, 7	...	...	...	
Trochus cinereus, Couth.	3, 1, 5	...	...	...	
,, *cinerarius*, L.	3, 1, 5	...	1	...	
,, *grœnlandicus*, Chemn.	3, 1, 5	...	...	...	
,, *varicosus*, M. & A.	3, 7, 1, 5	...	...	...	
,, *zizyphinus*, L.	3, 1, 5	...	...	...	
Trophon clathratus, L. (=*Boreotrophon*) ...	3, 1, 5, 7	...	2, 1	...	
,, ,, var. *gunneri*	3, 1, 5	...	...	...	
,, ,, var. *truncata*	3, 1, 5, 7	...	...	...	
,, *antiquus*, L.	...	...	1	8	
,, *bamffius*, Mont. = *truncatus* ...	...	...	1	...	
,, *fabricii*, Beck.	5, 1, 7	...	...	...	
,, *gracilis*, da'C.	...	...	1	...	
,, *latericeus*, Müll.	5, 1, 7	...	...	...	
,, *scalariformis*, Gould. = *clathratus*...	...	...	1	8	
Turritella erosa, Couth.	3, 1, 5, 7	1	...	...	
,, *terebra*, L....	5, 1, 7	1	1	8	
Turbella parva, da'Costa = *Rissoa parva*...	...	...	2	...	
Utriculus constrictus, Jeffr.	3, 1, 5	...	...	...	
,, *obtusus*, Mont., var. *pertenuis* ...	5, 1, 3	...	...	...	
Velutina undata, J. Smith	...	...	1	..	
FORAMINIFERA.					
Biloculina elongata d'Orb.	1, 5	...	...	...	
,, *ringens* Lam.	1, 3, 5, 12	1	...	...	
Bulimina marginata d'Orb.	...	1	...	...	
Cassidulina crassa, d'Orb.	1, 5	1	...	...	
,, *lævigata*, d'Orb.	1, 3, 4, 5, 12	1	...	...	
Cornuspira foliacea, Ph.	1, 4, 5, 12	...	...	...	
Cristellaria cultrata, Mont.	1, 5, 12	...	...	...	
,, *acutauricularis*, F. & M. ...	4	1	...	...	
Dentalina brevis, d'Orb.	1, 5, 12	...	...	...	
,, *communis*, d'Orb.	1, 3, 4, 5, 12	1	...	...	
,, *pauperata*, d'Orb.	1, 5	...	...	...	

NAME.	Bridlington.	Dimlington.	Kelsey Hill.	Burstwick.	Other Localities.
Gaudryina pupoides, d'Orb.	1, 3, 5	...	...	...	
Glandulina lævigata, d'Orb.	1, 3, 5	...	...	...	
,, ,, var. *rotundata*	1, 3, 5	...	...	...	
,, ,, var. *æqualis*	1, 3, 5	...	...	...	
Globigerina bulloides, d'Orb.	...	1	...	...	
Lagena globosa, Mont.	1, 3, 5	...	...	...	
,, *lævigata*, Reuss.	1, 3, 5	...	...	...	
,, *lævis*, Mont.	1, 5	...	...	...	
,, *squamosa*, Mont.	1, 3, 5, 12	...	...	...	
,, *sulcata*, W. & J.	1, 3, 5, 12	...	...	...	
Miliolina seminulum, L.	1, 5	1	...	...	
,, *oblonga*, Mont.	4	1	...	...	
Nonionina depressula, W. & J.	1, 5	1	...	...	
,, *orbicularis ?* Brady	1, 3, 4, 5	...	...	...	
,, *scapha*, F. & M.	1, 5, 12	...	...	...	
Polymorphina compressa, d'Orb.	1, 3, 5	...	...	...	
,, *lactea*, W. & J.	1, 3, 5, 12	...	...	...	
,, *lanceolata*, Reuss.	4	1	...	...	
,, *thouini*, d'Orb.	1, 5	...	...	...	
Polystomella crispa, L.	...	1	...	...	
,, *striato-punctata*, F. & M.	1, 3, 4, 5, 12	1	...	...	
Pulvinulina karsteni, Reuss.	1, 3, 5	...	...	...	
Quinqueloculina seminulum, L.	3, 1, 5, 12	...	...	...	
,, *triangularis*, d'Orb.	5, 1, 12	...	...	...	
Rotalia beccarii, L.	...	1	...	...	
Triloculina oblonga, Mont.	5, 1, 12	...	...	...	
Uvigerina angulosa, Williamson	...	1	...	...	
Vaginulina lævigata, Roemer	1	...	...	...	
,, *legumen*, L.	1	...	...	...	
Truncatulina lobatula, W. & J.	3, 4, 5, 12	...	...	...	

PRE-GLACIAL.

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NAME.	Sewerby.	Hessle.	Speeton.
MAMMALIA.			
Elephas (*? primigenius*)	2	4	...
,, *antiquus*	1	...	...
Rhinoceros leptorhinus	1	...	...
,, sp.	...	4	...
Hippopotamus amphibius	1	...	...
Equus caballus	...	4	...
,, sp.	2	...	...
Cervus elaphus	...	4	...
,, *tarandus*	...	4, 5	...
,, (*? megaceros*)	1	...	...
Bison sp.	1	...	...
Hyœna crocata var. *spelœo*	1	...	...
,, sp.	...	4	...
Arvicola amphibius	1	...	...
AVES.			
Birds	1	...	...
REPTILIA.			
Snake	2	...	...
PISCES.			
Gadus morrhua (cod)	1	...	...
MOLLUSCA.			
Helix hispida	1	...	...
,, *pulchella*	1	...	...
,, sp.	3	...	...
Pupa marginata = *P. muscorum*	3	...	...
Zua lubrica = *Z. subcylindrica*	1	...	...
Purpura lapillus	1	...	...
Littorina littorea	1	...	1
,, *rudis*	...	...	1
Ostrea edulis var.	1	...	...
Mytilus edulis	1	...	1
Pholas	1	...	...
Saxicava	1	...	...
Tellina balthica	...	...	1
Scrobicularia piperata	...	...	1
Cardium edule	...	...	1
Hydrobia ulvæ	...	...	1
Utriculus obtusus var. *pertenuis*	...	...	1

THE UPPER, MIDDLE AND LOWER CHALK.

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5. A. W. ROWE and C. D. SHERBORN. "The Chalk of the Yorkshire Coast," Proc. Geol. Asso., Feb., 1904.
6. In the collection of J. W. STATHER.
7. In the collection of J. R. MORTIMER, Driffield.
8. In the collection of H. C. DRAKE.
9. Collected by T. SHEPPARD.
10. "The Naturalist," 1906–7–8.
11. Professor BARROIS. "Recherches sur le Terrain Cretace de l'Angleterre et de l'Irlande."
12. Collected by C. THOMPSON and Dr. WALTON.
13. Collected by G. SHEPPARD.
14. HENRY WOODS. "Monograph of the Cretaceous Lamellibranchiata," Palæ. Soc., 1899-1908.
15. Collected by Mr. A. J. MOORE, and now in the Hull Museum.

UPPER CHALK.

NAME.	Sewerby to High Stack	Flamborough inland to Nafferton.	Driffield and Wolds.	Beverley District.
REPTILIA.	5	...	...	...
Mosasaurus sp.				
PISCES.	...	...	2	...
Ptychodus latissimus, Ag. ...	3	...	...	...
Scapanorhynchus raphiodon, Ag. ...	5	...	...	...
Oxyrhina mantelli, Ag.	5	...	...	...
Lamna appendiculata, Ag.... ...	5	...	...	...
Notidanus microdon, Ag.	9	...	...	...
Vertebræ of fish				
CEPHALOPODA.				
Ammonites (*Desmoceras*) *pseudo-gardeni*, Schlüt.	...	...	...	6
,, (*Haploceras*) *leptophyllus* ? Sharpe	5, 6	...	...	...
,, sp.	4	...	...	...
,, *lewesiensis*	...	...	2	...
Aptychus of *Ammonite*	5	...	...	...
Hamites sp.	6, 3	10	6	...
Scaphites binodosus ? Römer ...	6, 3, 5, 1	9, 6, 8	...	...
,, *inflatus ?* Defr.	3, 5	6, 10	...	...
Nautilus cf. *darupensis*, Schlüt. ...	6	...	...	...
,, *lævigatus*	...	...	2	...
,, *grossouvrei*	...	...	7, 10	...
Crioceras williamsoni, Phil. ...	1	...	...	...
Belemnitella granulata, Sow. ...	1	...	6	6
,, *mucronata*,* Blainv. ...	1	...	...	...
Actinocamax granulatus, Blain. ...	5, 6, 8, 9	11, 6, 10	...	6
,, *verus*, Miller ...	6, 5, 11	11	10	6
GASTEROPODA.				
Pleurotomaria perspectiva, Mantell.	5, 6	7	2	...
LAMELLIBRANCHIATA.				
Avicula tenuicostata, Römer ...	5, 6	...	7, 14	...
,, sp.	1, 6	...	...	...
Inoceramus brongniarti, Sow. ...	1, 3, 5	2	7	...
,, *digitatus*, Sow. ...	...	...	2, 7	...
,, *involutus*, Sow. ...	...	...	7, 2	...
,, *lingua*, Goldf. ...	5, 11, 6	...	6, 2	6
,, *mytiloides*, Schloth. ...	5, 3, 6, 1	...	7	...

* Apparently recorded in error.

NAME.	Sewerby to High Stacks	Flamborough inland to Nafferton.	Driffield and Wolds.	Beverley District.
Inoceramus lamarcki, Park.	5	...	...	...
,, cf. *undulatus*, Mantell.	5	...	...	...
,, cf. *cuneiformis*, d'Orb.	5	...	...	...
,, sp.	5, 3	...	...	...
,, *cuvieri*, Sow.	1, 5	...	...	...
,, *lobatus*, Sch.	8	9	...	...
Lima hoperi, Sow.	5, 3, 6	...	...	...
,, *? granosa*, Goldf.	5	...	...	...
Ostrea acutirostris, Nilss.	3, 6	...	...	...
,, *vesicularis*, Lam.	3, 5, 11	...	...	...
,, *hippopodium*, Nilss.	5	...	...	...
,, *wegmanniana*, d'Orb.	5, 6	...	...	...
,, *proboscidea*, d'Arch.	5	...	...	...
Spondylus latus, Sow.	5, 6	...	2, 7	...
,, *dutempleanus*, d'Orb.	5	...	...	...
,, *truncatus ?* d'Orb.	...	...	2, 7	...
,, *gibbosus*	1, 4	...	...	...
Pecten cretosus, Defr.	5	...	...	...
Plicatula sigillina, Woodward	5	...	...	...
Anomia sp.	...	...	2	...
Dianchora striata, Sow.	1	...	...	...
BRACHIOPODA.				
Crania egnabergensis, Retz.	6, 5	...	...	...
Thecidea sp.	5	...	...	...
Kingena lima, Defr.	6, 5	...	7	...
Terebratulina striata, Davidson	5, 1	...	...	...
,, *gracilis*, Schloth.	5	...	...	9
Terebratula semiglobosa, Sow.	6, 5, 3, 1	10	7, 2	...
,, *carnea*, Sow.	11,1,5,6,3	...	...	...
Rhynchonella plicatilis, Sow.	11, 3, 6	...	...	...
,, *limbata*, Schloth.	6, 5	...	...	...
,, *reedensis*, Etherid.	6, 8, 5	...	...	...
,, *cuvieri*, d'Orb.	5, 6, 3	...	2	...
,, *mantelliana*	...	...	2	...
ANNELIDA.				
Serpula ampullacea, Sow.	5	...	...	...
,, *fluctuata*, Sow.	5	...	...	...
,, *granulata*, Sow.	5, 6	...	...	...
,, *ilium*, Sow.	5	...	...	...
,, *turbinella*, Sow.	5	...	...	...
,, *plana*, S. Woodward	5	...	...	...
CRUSTACEA.				
Scalpellum maximum	5	...	...	...
Balanus sp.	5	...	...	...

NAME.	Sewerby to High Stacks.	Flamborough inland to Nafferton.	Driffield and Wolds.	Beverley District.
ECHINODERMATA.				
Cardiaster ananchytis, Leske. = (*granulosus*)	6, 3, 5	8	...	...
Cardiaster pillula, Lam.	5	6	7	...
,, *cotteani*, d'Orb. ...	5	...	...	...
Cidaris clavigera, König.	6, 5	...	...	...
,, *hirudo*, Sorig.	3	...	...	...
,, *septifera*, Mantell. ...	6, 5	...	...	...
,, *subvesiculosa*, d'Orb. ...	3	2	...	...
,, sp.	8	...	...	...
Cyphosoma königi, Mantell. ...	3, 1	2	...	...
,, *radiatum*, Sorig. ...	6, 5	...	...	...
,, *corollare*, Klein ...	5	...	...	...
Salenia granulosa, Forbes	5	2	...	...
Zeuglopleurus rowei, Greg. ...	5	...	...	...
Echinocorys scutatus, Leske. (=*vulgaris*, Breyn.)... ...	8, 6	7	7	...
Ananchytes ovatus, Leske. (*Echinocorys scutatus*, Leske)	1, 6, 5, 8	...	...	...
,, *hemisphæricus*, Cuv. (*Echinocorys scutatus*, Leske.)	1	...	...	...
Echinoconus subrotundus, Mant. ...	1	...	...	...
,, *albogalerus*, Klein ...	...	...	...	Hessle 1
Micraster cor-anguinum, Leske. ...	1, 6, 5, 3	2	7	...
,, *cor-testudinarium ?* Goldf.	3, 5, 6	2	7	...
,, *leskei*, Desm. (= *breviporous*)	5	...	...	...
,, *præcursor*	5	...	...	...
Holaster planus, Mantell.	6, 5	...	...	...
,, *placenta*, Ag.	5	...	...	...
,, *hemisphæricus*, Phil. ...	1	...	...	...
,, *trecensis*	2	...	...	...
Offaster pillula, *Lam*. (=*Cardiaster*)	5	...	7	...
Infulaster excentricus, Forbes ...	6, 2	...	...	...
,, *rostratus*, Forbes ...	6, 5, 2	...	...	...
Hemiaster minimus, Ag.	5	...	...	...
Pentagonaster (ossicles)	6	...	...	...
Marsupites testudinarius, Miller (=*ornatus*) ...	6, 5, 8, 1	...	...	6
,, *lævigatus*	...	2	...	...
Uintacrinus westfalicus, Schl. [?] ...	6, 5, 8	...	...	...
Bourgueticrinus ellipticus, Miller ...	3, 6, 5, 1	2	...	...
,, sp.	...	2	...	...
Pentacrinus sp.	5, 8	...	...	...
Asteroidea sp.	5	...	...	...
Ophiura sp.	5	...	...	...

NAME.	Sewerby to High Stacks.	Flamborough inland to Nafferton.	Driffield and Wolds.	Beverley District.
ACTINOZOA.				
Cœlosmilia laxa, E. and H.	5	...	...	...
Parasmilia centralis, Mantell.	5, 6, 1	...	...	...
,, *fittoni*, E. and H.	5	...	...	...
,, *cylindrica*, E. and H. (=*Caryophyllia*)	5, 6	...	...	...
,, *granulata*, Duncan	5	...	...	...
,, *monilis*, E. and H.	...	...	...	...
Axogaster cretacea, Lonsdale	5	...	...	...
PORIFERA.				
Bolospongia constricta, Hinde	3	...	...	...
,, *globata*, Hinde	8	...	...	...
Camerospongia capitata, Toulmin Smith	1, 3	...	...	...
Cœloptychium agaricoides, Goldf.	3, 5	...	2	...
Isoraphina texta, Römer	3, 8	...	...	...
Manon marginatum, Phil.	1, 3	...	...	...
Jereica clava, Lee	3	...	...	...
Pachinion scriptum, Hinde	3, 8	...	...	...
Pachastrella convoluta, Hinde	3, 8	...	...	...
Phymatella reticulata, Hinde	3, 8, 6	8	...	...
Porosphœra globularis, Phil.	1, 8, 6, 5, 3	...	...	...
,, *pileolus*, Lam.	1, 8, 6, 5, 3	...	...	...
Scytalia fastigiata, Lee	3, 6, 8	...	...	...
,, *radiciformis*, Phil.	3, 6, 8, 1	...	...	...
,, *terebrata*, Phil.	3, 1	...	...	...
Scyphia pedunculata, Römer	3	2	...	...
Seliscothon planum, Phil.	1, 6, 5, 8, 3	6, 7	7	...
,, *explanatum*, Römer	3	...	...	...
Stichophyma tumidum, Hinde	3	...	...	...
Tethyopsis cretaceus, Hinde	3	...	...	...
Turonia variabilis, Mich.	3	...	...	...
Verruculina astrea, Hinde	3	...	...	...
,, *miliaris*, Reuss	3, 8	...	...	...
,, *papillata*, Hinde	3, 8, 6	...	...	...
,, *plicata*, Hinde	3, 8	8	...	...
,, *pustulosa*, Hinde	3, 8	...	...	...
,, *reusii*, McCoy	3	...	...	...
Ventriculites cribrosus, Phil.	3, 5, 1, 8	6	...	...
,, *infundibuliformis*, S. Wood.	3, 8	8, 2	8	6
,, *radiatus*, Mantell.	3, 8, 6	...	...	...
,, *impressus*, T. Smith	3	...	...	...
,, *convolutus*, Hinde	3	...	...	...
,, *decurrens*, T. Smith	3	...	...	...
Plocoscyphia convoluta, T. Smith	5, 8, 9	...	...	...

NAME.	Sewerby to High Stacks.	Flamborough inland to Nafferton.	Driffield and Wolds.	Beverley District.
Porochonia simplex, T. Smith ...	5	...	...	...
Coscinospora infundibuliformis, Goldf.	5	...	...	...
Guettardia stellata, Mich.	5	...	...	...
Leptophragma murchisoni, Goldf....	5	...	...	...
Callopegma obconicum, Hinde ...	5	...	...	...
Heterostinia obliqua, Benett ...	5	...	...	...
Siphonia königi, Mantell.	5, 8	...	...	...
Stelleta inclusa ? Hinde	5	...	...	...
Cliona cretacea, Portlock	5	...	...	...
Porosphœra globularis and var. *nuciformis*, Hinde ...	5, 8, 6, 9	...	...	...
,, *pileolus* var. *patelliformis*, Hinde	5, 8, 6	...	...	...
,, *pileolus* var. *arrecta*, Hinde	5	...	...	...
Spinopora dixoni, Lonsdale ...	5	...	...	...
Branchiolites sp.	...	2	...	...
BRYOZOA.				
Cellepora zenobia ?	...	2	...	...
Alecto longiscata ?	...	2	...	...
Siphoniotyphlus plumatus	...	2	...	...
FORAMINIFERA.				
Zone of *Holaster planus*.				
Rhizammina sp.	...	...	3	...
Ammodiscus sp.	...	...	3	...
Zone of *Micraster cor-testudinarium*				
Ammodiscus sp.	...	...	3	...
,, with shorter tube lengths...	...	...	3	...
Rhizammina sp.	...	...	3	...
Zone of *Micraster cor-anguinum*.				
Ammodiscus sp.	...	...	...	3
Textularia sp.	...	...	...	3
Globigerina sp.	...	...	...	3
Zone of *Marsupites*.				
Rhizammina indivisa	...	3	...	...
Rheophax sp.	...	3	...	...
Ammodiscus incertus	...	3	...	...
Haplophragmium sp.	...	3	...	...
Textularia sp.	...	3	...	...
Globigerina sp.	...	3	...	...

NAME.	Sewerby to High Stacks.	Flamborough inland to Nafferton.	Driffield and Wolds.	Beverley District.
Zone of *Actinocamax quadratus*.				
Ammodiscus incertus	3	...	...	...
Verneuilina triquetra	3	...	...	...
Bulimina brevis	3	...	...	...
,, *obtrusa*	3	...	...	...
Cristellaria rotulata	3	...	...	...
Truncatulina ungeriana	3	...	...	...
Anomalina ammonoides	3	...	...	...
Pulvinulina micheliniana	3	...	...	...
Rotalia exculpta	3	...	...	...
Rhizammina algæformis	3	...	...	...

MIDDLE CHALK.

NAME.	Flamborough Head and District.	Other Places.
T.G. = Zone of *Terebratulina gracilis*.		
R.C. = Zone of *Rhynchonella cuvieri*.		
PISCES.		
Ichthyodectes or *Portheus* sp.	...	Hessle 15
Ptychodus mammillaris, Ag. (R.C.)	...	9, 2, 6
CEPHALOPODA.		
Belemnite (*Actinocamax* sp.) (T.G.)	...	Lund 8
LAMELLIBRANCHIATA.		
Inoceramus brongniarti, Sow. (T.G.)	3, 2, 5	...
,, *cuvieri*, Sow. (T.G.)	3, 2	Beverley 6
,, *mytiloides*, Sow. (R.C.)	3, 2	Willerby 8, 13
,, *undulatus*, Mantell. (T.G.)	3, 2	...
,, *lamarcki*, Park (R.C.)	5	...
Ostrea vesicularis, Lam. (T.G.)	3	...
,, *hippopodium*, Nilss. (T.G.)	5	...
,, *proboscidea*, d'Arch. (T.G.)	5	...
Spondylus fimbriatus, Goldf. (T.G.)	3, 2	Beverley 6

NAME.	Flamborough Head and District.	Other Places.
GASTEROPODA.		
Pleurotomaria perspectiva (T.G.)	...	6
BRACHIOPODA.		
Rhynchonella cuvieri, d'Orb. (R.C. and T.G.)	3, 5, 2	6
,, *reedensis*, Eth. (T.G.)	5	...
Terebratula semiglobosa, Sow. (R.C. and T.G.)	2, 3, 5	6
,, *carnea*, Sow. (T.G.)	5	...
Terebratulina striata, Dav. (T.G.)	2, 3, 5	...
,, *gracilis*, Schloth. (and var. *lata*) (T.G.)	2, 3, 5	Mkt. Weight'd 9
Crania egnabergensis, Retz. (T.G.)	5, 6	Willerby 8, 13
Kingena lima, Defr. (T.G.)	5	...
PORIFERA.		
Ventriculites sp. (T.G.)	...	South Cave 6, 8, 9
Porosphæra globularis (T.G.)	5	...
Species undetermined	...	6, 8, 9
ECHINODERMATA.		
Bourgueticrinus ellipticus, Mil. (T.G.)	3, 5	...
Conulus subrotundus, Mantell. (T.G.)	3	Hessle 13
Holaster planus, Mantell. (T.G.)	3	...
Salenia granulata, Forbes (T.G.)	3, 2	...
Micraster præcursor ? (T.G.)	...	Willerby and Mkt. Weight'd 13, 6, 8
Echinocorys scutatus (*Ananchytes ovatus*), Leske (T.G.)	...	13, 6, 8, 9
Asteroidea (T.G.)	5	...
POLYZOA.		
Two species on *Micrasters*	...	Willerby 13, 8
FORAMINIFERA.		
Rhizammina indivisa, Brady	...	Hessle 3
Ammodiscus incertus, d'Orb.	...	3
,, *gordialis*, J. and P.	...	3

LOWER CHALK.

NAME.	Speeton.	South Cave Cutting.	Other Places.
A.V. = Zone of *Ammonites varians*			
H.S. = ,, *Holaster subglobosus*			
A.P. = ,, *Actinocamax plenus*			
PISCES.			
Fish remains (all three zones)	3	3	Melton 8
CEPHALOPODA.			
Acanthoceras rotomagensis, Defr. (A.V.) ...	...	3	...
,, *lacticlavius*, Sharpe (H.S.)...	3	...	...
Pachydiscus peramplus (A.V.)	1	...	Garrowby 2
Ammonites sp. ?	...	...	Wharram 7
Schlœnbachia varians, Sow. (A.V.)... ..	2, 11	...	...
Nautilus bouchardianus (A.V.)	...	...	2
Baculites baculoides, Sow. (A.V.)	3	...	...
Turrilites tuberculatus, Bosc. (A.V.) ..	...	3	3
Actinocamax plenus, Blain (A.P.)... ..	...	...	Melton 12
,, *lanceolatus*, Sow. (H.S.) ..	...	3	...
Belemnites minimus (A.V.)...	3	...	...
LAMELLIBRANCHIATA.			
Ostrea vesicularis, Lam. (all zones) ..	3	3	3
Avicula lineata, Römer (H.S.)	...	...	3, 2
Aucellina gryphœoides, Sow. (A.V.) ..	3	...	3
Plicatula inflata, Sow. (A.V. and H.S.) ...	3	3	3
Pecten orbicularis, Sow. (H.S.)	3	3	3
Lima echinata, Eth. (A.V. and H.S.) ..	3	3	...
,, *globosa*, Sow. (H.S.)...	...	3	...
Inoceramus latus, Mantell. (A.V. and H.S.)	3	3	...
,, *cuvieri*, Sow. (A.V. and H.S.)...	3	3	3
,, *striatus*, Mantell. (A.V.) ...	2, 11	...	...
Spondylus latus, Sow. (H.S.)	...	3	...
,, *dutempleanus*, d'Orb. (H.S.) ...	...	3	...
,, *striatus*, Sow. (H.S.)	...	3	...
BRACHIOPODA.			
Kingena lima, Defr. (all zones)	3, 11	3	3
Rhynchonella grasiana, d'Orb.	...	3	...
,, *lineolata*, Phil.	3	...	3
,, *mantelliana*, Sow.	3	...	...

NAME.	Speeton.	South Cave Cutting.	Other Places.
Terebratula biplicata, Sow.	3, 11, 2	3	3
,, ,, var. *faba*, Sow.	3	...	...
,, *semiglobosa*	3, 11, 2	3	3
,, ,, var. *subundata*, Sow.	3, 11	...	...
,, *squamosa*, Sow.	3	...	...
,, *sulcifera*, Morris	3	...	...
,, *subundata*, Sow.	3	...	...
Terebratulina gracilis var. *nodulosa*, Eth.	3	...	...
,, *triangularis ?* Eth.	3	...	...
CRUSTACEA.			
Glyphæa cretacea ? McCoy	...	3	...
ANNELIDA.			
Serpula antiquata, Sow.	3	3	...
,, *umbonata*, Sow.	3	3	...
ECHINODERMATA.			
Cidaris dissimilis, Forbes	3	...	...
,, *vesiculosa*, Goldf.	3	...	...
Cyphosoma sp.	3	...	...
Discoidea cylindrica, Lam.	3	3	3
Holaster lævis	3, 8	...	...
,, *subglobosus*, Leske	3	3	3
,, *trecensis ?* Leym.	3	...	...
,, *rotundus*	3	3	3
Peltastes stellulatus, Ag.	3	...	...
Pseudodiadema sp.	11	...	...
FORAMINIFERA.			
Rhizammina indivisa, Brady	3	...	...
Rheophax nodulosa, Brady	3	...	...
Haplophragmium glomeratum, Brady	3	...	...
Ammodiscus incertus, d'Orb.	3	...	...
,, *charoides*, J. and P.	3	...	...
Trochammina sp.	3	3	...
Lituola placentula, Chap.	3	...	...
Gaudryina pupoides, d'Orb.	3	...	...
,, *rugosa*, d'Orb.	3	...	...
sp. nov.	3	...	...
Bulimina brevis, d'Orb.	3	...	...
,, *presli*, Reuss.	3	...	...
,, *affinis*, d'Orb.	3	...	...
,, *obtusa*, d'Orb.	3	...	...
Truncatulina lobatula (W. and S.)	3	...	...
Pleurostomella sp.	3	3	...

RED CHALK.

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RED CHALK.

NAME.	Speeton.	South Cave.	Other Places.
REPTILIA.			
Tooth of Saurian	15	...	...
PISCES.			
Oxyrhina mantelli (tooth)	7	...	...
Notidanus (tooth)	6	...	...
Lamna sp. (vertebræ)	4, 8, 12	...	...
Pachyrhizodus sp. (vertebræ)	4, 12	...	...
CEPHALOPODA.			
Pachydiscus peramplus (see P.G.A., Jan., 1878, p. 247)	...	...	GarrowbyPk. 2
Hoplites deshayesi, Leym.	...	...	2
,, *auritus ?* Sow.	...	...	Wharram Gr. & Givendale 1
Schlœnbachia rostrata, Sow.	...	1	...
,, *? varicosa,* Sow.	8	...	...
Belemnites minimus, Lister	1, 3, 15, 12	1, 2, 3, 9	1, 2, 3
,, *listeri,* Phil.	5, 15	...	...
,, *attenuatus,* Phil.	5	...	...
,, *ultimus*	15	...	...
Nautilus elegans, Sow. (*? albensis*) ...	...	...	Wharram Gr. 1
,, sp. (*? bouchardianus,* d'Orb.) ...	...	...	Burdale, Garrowby Pk. &c. 2
LAMELLIBRANCHIATA.			
Avicula gryphœoides, Sow.	1, 5, 15	1	2
Exogyra rauliniana, d'Orb. (*Ostrea,* Phillips)	10, 5	...	...
Ostrea canaliculata, Sow.	10, 5	...	...
,, *vesicularis,* Sow.	10	...	...
,, *vesiculosa,* Sow.	5, 10	...	...
Pecten beaveri, Sow.	5, 15	...	1
Plicatula pectinoides, Sow.	...	...	2, 10
Inoceramus crispi, Mantell.	1	...	...
,, *sulcatus,* Park.	10	1	1, 2
,, *tenuis,* Mantell.	11	...	...
,, *coquandinus,* Phil.	5, 15	...	...
,, *lœviusculus*	15	...	...
Spondylus gibbosus, d'Orb.	5, 10	...	...
,, *striatus ?* Sow.	11	...	...
,, *latus*	15	...	...

NAME.	Speeton.	South Cave.	Other Places.
BRACHIOPODA.			
Kingena lima, Defr.	11	...	Wharram Gr. 1
Rhynchonella lineolata, Phil.	11	...	Burdale 2
,, *sulcata*, Park.	10	...	Burdale 1
,, *wiestii*, Blake	...	...	2
,, *latissima* (*? sulcata*)	10	...	10, 2
Magas pumila, Sow.	5	...	
Terebratula biplicata, Sow.	1	1	Burdale 1, 2
,, ,, var. *dutempleana*	1	...	1
,, *capillata*, d'Arch.	11	1	Burdale 1, 2
,, *semiglobosa*, Sow.	1, 5, 15	1, 9	Burdale 1, 2
,, *sulcifera ?* Morris	10	...	10, 2
,, *subundata*	5	...	...
Terebratulina gracilis, Schloth. (Q.J.G.S., 1888)	1	...	Burdale 1
,, *triangularis*, Eth.	10	...	10
,, *striata*, Wahl. (*T. pentagonalis*, Phil.)	10, 5	...	...
,, *rigida*, Sow.	5	...	...
POLYZOA.			
Proboscina dilatata, d'Orb.	10, 5	...	...
Ceriopora spongitis, Goldf.	10, 5, 15	...	...
Idmonea dilatata	15	...	...
CRUSTACEA.			
Pollicipes unguis, Sow.	10, 5	...	...
Cytherella ovata, Römer	10, 5, 15	...	...
ECHINODERMATA.			
Cidaris gaultina, Forbes	11, 3, 5	...	2
Torynocrinus rugosus, Seeley	10, 3	...	2
Holaster (*Cardiaster*) *suborbicularis*, Defr.	10	...	Wharram Gr. 1
Discoidea cylindrica, Lam.	5	...	...
Pentacrinus fittoni, Aust.	10, 5, 3	...	2
Peltastes stellulatus, Ag.	5	...	...
ANNELIDA.			
Serpula concava, Sow.	10	...	...
,, *umbonata*, Sow.	10, 5	...	...
,, *solitaria*, Phil.	5	...	...
Vermicularia elongata, Bean MS.	15	...	...

NAME.	Speeton.	South Cave.	Other Places.
FORAMINIFERA.			
Ammodiscus gordialis, J. and P.	10	...	...
,, *incertus*, d'Orb.	10	...	...
,, *tenuis*, Brady	10	...	...
Anomalina ammonoides, Reuss.	10	...	...
,, *grosserugosa*, Gümb	10	...	...
Bolivina textilarioides, Reuss.	10	...	...
,, *beyrichi*, Reuss., var. *alata*	10	...	...
Bulimina affinis, d'Orb.	10	...	...
,, *presli*, Reuss.	10	...	...
Cristellaria cultrata, Montf.	10	...	...
,, *rotulata*	5	...	...
,, *cymboides*, d'Orb.	10	...	...
,, *gibba*, d'Orb.	10	...	...
,, *italica*, Defr.	10	...	...
,, *lata*, Reuss.	10	...	...
,, *marcki*, Reuss.	10	...	...
,, *multisepta*, Reuss.	10	...	...
,, *variabilis*, Reuss.	10	...	...
Frondicularia biformis, Marsson.	10	...	...
,, *gaulteria*, Reuss.	10	...	...
Gaudryina pupoides, d'Orb.	10	...	...
Globigerina bulloides, d'Orb.	10	...	...
,, *cretacea*, d'Orb.	10, 5	...	...
,, *linnæana*, d'Orb.	10	...	...
Lagena apiculata, Reuss.	10	...	...
,, ,, var. *emaciata*, Reuss.	10	...	...
,, *cincta*, Leg.	10	...	...
,, *globosa*, Mont.	10	...	...
,, *lævis*, Mont.	10	...	...
Lingulina nodosaria, Reuss.	10	...	...
Marginulina glabra, d'Orb.	10	...	...
,, *inæqualis*, Reuss.	10	...	...
,, *variabilis*, Neug.	10	...	...
Nodosaria abnormis, Reuss.	10	...	...
,, *brevis*, d'Orb.	10	...	...
,, (*Glandulina*) *candela*, Egger.	10	...	...
,, *calomorpha*, Reuss.	10	...	...
,, (*Dentalina*) *communis*, d'Orb.	10	...	...
,, (*Glandulina*) *cylindracea*, Reuss.	10	...	...
,, (*Dentalina*) *filiformis*, d'Orb.	10	...	...
,, (*Glandulina*) *lævigata*, d'Orb.	10	...	...
,, *limbata*, d'Orb.	10	...	...
,, *longiscata*, d'Orb.	10	...	...
,, (*Glandulina*) *marginulinoides*, Reuss.	10	...	...
,, (*Dentalina*) *mucronata*, Neug.	10	...	...
,, *obtussissima*, Reuss.	10	...	...
,, (*Dentalina*) *obscura*, Reuss.	10	...	...
,, *oligostega*, Reuss.	10	...	...
,, *prismatica*, Reuss.	10	...	...
,, *radicula*, L., var. *jonesi*, Reuss.	10	...	...

NAME.	Speeton.	South Cave.	Other Places.
Nodosaria soluta, Reuss.	10	...	...
Orbulina universa, d'Orb.	10	...	...
Pleurostomella alternans, Schw.	10	...	...
,, *subnodosa*, Reuss.	10	...	...
Polymorphina compressa, d'Orb.	10	...	...
,, *fusiformis* var. *horrida*, Reuss.	10	...	...
,, *gibba*, d'Orb.	10	...	...
,, *lactea*, W. and J.	10	...	...
,, *sororia*, Reuss.	10	...	...
Polystomella macella, F. and M.	10	...	...
Pulvinulina menardi, d'Orb.	10	...	...
Ramulina aculeata, Wright	10	...	...
Rhabdogonium excavatum, Reuss.	10	...	...
,, *tricarinatum* var. *acutangulum*, Reuss.	10	...	...
Sphæroidina bulloides, d'Orb.	10	...	...
Spiroloculina papyracea, B. and B.	10	...	...
,, *tenuis*, Czjzek.	10	...	...
Spiroplecta biformis, P. and J.	10	...	...
Textularia agglutinans, d'Orb.	10	...	...
,, *attenuata*, Reuss.	10	...	...
,, *complanata*, Reuss.	10	...	...
,, *gramen*, d'Orb.	10	...	...
,, *minuta*, Berth.	10	...	...
,, *prælonga*, Reuss.	10	...	...
,, *trochus*, d'Orb.	10	...	...
,, *turris*, d'Orb.	10	...	...
Truncatulina variabilis, d'Orb.	10	...	...
Vaginulina arguta, Reuss.	10	...	...
,, *legumen*, Lin.	10	...	...
,, *recta*, Reuss.	10	...	...
,, *truncata*, Reuss.	10	...	...
Verneuillina propinqua, Brady	10	...	...
,, *triquetra*, Münst.	10	...	...

SPEETON CLAY.

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SPEETON CLAY.

NAME.	Speeton.	Knapton.
THE UPPERMOST BED.		
PISCES.		
Scales of Fish	2	...
CEPHALOPODA.		
Belemnites minimus, List.	2, 3	...
,, *attenuatus*, Sow.	2, 3	...
,, *ultimus*, d'Orb.	2, 3	...
,, *ewaldi*, Strom.	3	...
Hoplites interruptus, Brug.	3, 7	...
,, *deshayesi*	8	...
,, *plana*	8	...
Crioceras ? fassicostatum, Römer	3	...
LAMELLIBRANCHIATA.		
Inoceramus concentricus, Park.	2	...
,, *sulcatus* var. *?* Park.	2	...
,, sp. (larger form)	2	...
Ostrea sp.	2	...
Avicula rauliniana ? d'Orb.	2	...
Nucula pectinata ? Sow.	2	...
BRACHIOPODA.		
Lingula sp.	2	...
ANNELIDA.		
Vermicularia elongata	2	...
ECHINODERMATA.		
Echinospatangus cordiformis, Breyn	2	...
Cidaris (spines)	2	...
Foraminifera sp.	2	...
Wood	2	...
Zone of *Belemnites semicanaliculatus*.		

NAME.	Speeton.	Knapton.
PISCES.		
Fish remains	2	...
CEPHALOPODA.		
Belemnites semicanaliculatus ? = (*B. brunsvicensis*), Stromb.	2, 3, 1, 9	...
,, (resembling *sulcatus*)	2	...
,, *jaculum*, Phil.	2, 1	...
,, sp. (extreme form of *jaculum ?*)	2	...
,, sp. (resembling *lateralis*, but distinct species)	2, 1	...
,, *speetonensis*, Stromb.	2	...
,, *absolutiformis*, Pavlov	2	...
,, *jasikowi*, Lahus	2	...
,, *obtusirostris*, Pavlov	2	...
Ammonites (*Olcostephanus* = *Simbirskites*) *discofalcatus* or *Phillipsii*	3	...
,, (*Olcostephanus* = *Oppelia*) *nisoides*	3	...
,, (*Hoplites*) *deshayesi*, Leym.	2, 3	2
,, (*Amaltheus*) *bicurvatus*, Mich.	2	...
,, *nucleus ?* Phil.	2, 1	...
Crioceras strombecki, von Könen	3	...
,, *matheroni*, Pavlov	3	...
Ancyloceras sp. (*? grandis*)	3, 2, 9	...
,, sp.	3, 2	...
Toxoceras royeri, d'Orb.	3	...
Scaphites constrictus ? d'Orb.	3	...
Hamites sp.	2	...
Nautilus sp.	2	...
GASTEROPODA.		
Rostellaria phillipsii, Römer = *R. parkinsoni*, Phil.	2	...
,, *candidula*, Forbes MS.	2	...
,, *bicarinata*, Leym., Judd	2	...
Pleurotomaria sp.	2	...
,, *provincialis*, d'Orb.	1	...
Turbo sp.	2	...
Trochus sp.	1	...
Dentalium lævigatum	1	...
LAMELLIBRANCHIATA.		
Ostrea sp.	2	...
Exogyra (*sinuata*, Sow. of Judd) varieties	2, 4, 1	...
Pecten orbicularis, Sow.	2	...
Lima, sp.	2, 1	...
Pinna tetragona, Sow. (*? gracilis*, Phil.)	2	...
,, *robinaldina*, d'Orb.	...	...

NAME.	Speeton.	Knapton.
Cucullæa securis, Leym. (*Grammatodon securis*, Leym.)	2	...
Nucula (similar to *menkii*, Römer)	2	...
,, *subangulata*	2	...
,, *impressa*, Sow.	2	...
Mya ? phaseolina, Phil.	2	...
Isocardia angulata, Phil. (= *Corbula angulata*)	2, 5	...
Astarte lævis, Phil.	2	...
Panopæa neocomiensis, Leym.	2	...
Pholadomya martini, Forbes	2	2
,, *speetonensis*	13	...
Lima subrigida, Römer	5	...
,, (*acesta*) *longa*, Römer	5	...
,, (*Mantellum*) *parallela*, Sow.	5	...
BRACHIOPODA.		
Terebratula seeleyi, Walker	2	...
Rhynchonella sulcata, Park.	2, 1	...
ANNELIDA.		
Serpula plexus ? Sow.	2	...
,, *antiquata*, Sow.	2	...
Vermicularia Sowerbyi, Phil.	2	...
Zone of *Belemnites jaculum*.		
PISCES.		
Vertebræ and teeth of fish	2, 11	...
CEPHALOPODA.		
Belemnites jaculum, Phil.	3, 1, 10	...
,, *jasikowi*, Lahus.	3	...
,, *pistillirostris*, Pavlov	3	...
,, *cristatus*, Pavlov	3	...
,, *subquadratus*, d'Orb.	3	...
,, *jaculum* var. *pistilliformis*, Blainv.	2	...
,, resembling *sulcatus*, Mill.	2	...
,, *explanatoides*, Pavlov	3	...
Ammonites (*Olcostephanus* = *Simbirskites*) *decheni*, Römer	3	...
,, ,, ,, *umbonatus*, Lahus.	3	...
,, ,, ,, *discofalcatus*, Lahus.	3, 7	...

NAME.	Speeton.	Knapton.
Ammonites (*Olcostephanus* = *Simbirskites*) *speetonensis* G. and B.	3	...
,, ,, ,, *progrediens*, Lahus....	3	...
,, ,, ,, *concinnus*, Phil. ...	3, 7, 10	...
,, ,, ,, cf. *carteroni*, d'Orb....	3	...
,, (*Olcostephanus* = *Holcodiscus*) *rotula*, d'Orb.	3, 10	...
,, *cryptoceras*, d'Orb.	1	...
,, *crassicostatus*, d'Orb.	1	...
,, (*Olcostephanus* = *Simbirskites*) *subinversus*, Pavlov...	2, 7	...
,, ,, ,, *inversus*, Pavlov...	2, 7	...
,, ,, ,, *payeri*, Toula. ...	2	...
,, ,, ,, *versicolor ?* Trautsch.	2	...
,, ,, ,, *phillipsii*...	2	...
,, (*Olcostephanus* = *Astieria*) *astieri*, d'Orb....	2	...
,, ,, ,, *sulcosus*, Pavlov	2	...
,, ,, ,, *atherstoni*, Sharpe...	2	...
,, ,, ,, *spitiensis*, Blanford	2	...
,, (*? Desmoceras*) cf. *cassidoides*, Uhl. ...	2	...
,, *noricus*, Schloth. (and varieties)... ...	2, 1	2
,, *speetonensis*, Y. and B., var. *concinnus*, Phil.	2,1,9,10	...
,, *speetonensis* var. *venustus* Phil. ...	2, 1, 10	...
,, *nisus ?* d'Orb. (*planus*, Phil.)	2, 1	...
,, *nucleus*, Phil.	2, 1	...
,, *angulicostatus*, d'Orb	2, 1	...
,, *marginatus*, Phil.	2, 1	...
,, *astierianus*, d'Orb.	2, 1	...
,, *hystrix ?* Phil.	2, 1	...
,, (*Hoplites*) *regalis*, Bean...	2, 7	...
,, ,, *amblygonius*, N. and U. ...	2, 7	...
,, ,, *roubaudi* (*munitus*), d'Orb. ...	2	...
,, ,, cf. *enthymi*, Pictet.	2	...
,, ,, *heteroptychus*, Pavlov	2	...
,, ,, *mortelletii*, Pictet and Lor. ...	2, 3	...
,, *bipinnatus*	9	...
,, *multiplicatus*	9	...
Crioceras cf. *matheroni*, d'Orb.	2, 3	...
,, *capricornus*, Römer	3, 2	...
,, *duvali*, d'Orb. (*Ancyloceras*, Léveille) ...	3, 2, 1	...
,, *semicinctum*, Römer	3, 2	...
,, *puzosianum ?* d'Orb. = *lignatus*, Bean MS.	3, 2	...
,, *raricinctum*, von Könen	3	...
,, *emericii*, Léveille (*Ancyloceras*)	1	...
Hamites intermedius, Phil.	3	...

NAME.	Speeton.	Knapton.
Gasteropoda.		
Rostellaria phillipsii, Römer = *R. parkinsoni*, Phil.	2, 1	...
,, *bicarinata*, Leym.	1	...
,, sp.	2	...
Cerithium aculeatum, Forbes	2	...
,, *phillipsii ?* Leym.	1	...
Pleurotomaria sp.	2	...
Trochus pulcherrimus, Phil.	2	...
Dentalium sp.	2	...
,, *lævigatum*, Bean MS.	2	...
Lamellibranchiata.		
Ostrea ? frons, Park.	2, 1	...
,, sp.	2	...
Exogyra sinuata, Sow.	2, 1	...
Pecten lens, Sow. var. *morini*, de Lor.	2	...
,, *cinctus*, Sow.	2, 1	...
,, sp.	2	...
,, sp.	2	...
Lima (*Mantellum*) *parallela*, Sow.	2, 1, 5	...
,, ,, *gaultina*, Sow.	5	...
Plicatula sp.	2	...
Avicula sp.	2	...
Inoceramus venustulus, Bean MS.	2	...
,, *imbricatus*, Bean MS.	2	...
Nucula subangulata ? Forbes MS.	2	...
,, *subrecurva*, Phil.	2	...
,, *vibrayeana*, d'Orb.	2	...
Nuculana speetonensis (= *Nucula equilateralis*), Bean MS.	2	...
,, (*? Yoldia*) *scapha* (= *Leda scapha*, Gardner)	5, 2	...
,, *seeleyi* = *Leda seeleyi*, Gardner	2	...
Aucella keyserlingiana, Trautschold (= *Perna imbricata* and *venustula*), Bean MS. and J. Phillips	5	
Isocardia angulata, Phil. (= *Corbula angulata*)	2, 5	...
Mya ? phaseolina, Phil.	2	...
Panopæa (*? neocomiensis*, Desh. sp. Judd.)	2, 1	...
Thracia phillipsii, Römer (= *Mya depressa*)	2, 1, 8	...
Pholadomya martini, Forbes	2, 1	2
Lucina sculpta, Phil.	1	...
,, *crassa*, Sow.	1	...
Brachiopoda.		
Terebratula depressa, Lam.	2, 1	...
,, *sella*, Sow.	2	...
,, *moutoniana*, d'Orb.	2	...
,, sp.	2	...
Rhynchonella sulcata, Park.	2, 1	...
,, *speetonensis*, Dav.	2	...
Terebratulina martiniana, d'Orb.	2	2
Waldheimia celtica, Morris, Dav. (Judd.)	4, 1	...
,, *faba*, d'Orb.	...	4

NAME.	Speeton.	Knapton.
ANNELIDA.		
Serpula articulata, Sow.	2, 1, 9	...
,, *antiquata*, Sow.	2, 1	...
,, *gastrochœnoides*, Leym.	1	...
Vermicularia phillipsii, Römer	2, 1	...
ECHINODERMATA.		
Pentacrinus angulatus, Römer	1	...
,, *annulatus*, Römer	2, 1	...
Echinospatangus cordiformis, Breyn. = *Toxaster complanatus*, Ag.	2	...
Cidaris (spines)	2	...
ACTINOZOA.		
Trochocyathus conulus, Phil.	2	...
CRUSTACEA.		
Meyeria ornata, Phil. = *Astacoides falcifer*, Bell ...	2	...
Palinuridia scarburgensis	2	...
Hoploparia prismatica, McCoy	2	...
,, sp. (*chelæ*)	2	...
Foraminifera	2	...
Wood	2	...
PORIFERA.		
Sponges sp.	1	...
Clionæ (crypts)	1	...
Zone of *B. lateralis*.		
REPTILIA.		
Plesiosaurus sp. (vertebræ and paddles)	1	...
Teleosaurus (skull)	1	...
Saurian remains	1, 3, 2	...
PISCES.		
Gyrodus minor, Ag. (Vertebræ and teeth)	4	...
Hybodus sp. ,, ,, ...	4	...
Macropoma (*Eurypoma*) *egertoni*, Ag. (Vertebræ & teeth)	4	...
sp. ,, ,,	2	...
Lamna sp. ,, ,,	1	...

NAME.	Speeton.	Knapton.
CEPHALOPODA.		
Ammonites (*Olcostephanus* = *Holcodiscus*) *rotula*, Sow.	3	...
.. .. = *Polyptchites*) *bidichotomus*, Leym.	3	...
.. .. ,, *keyserlingi*, N. and U.	3	...
.. .. ,, *gravesiformis*, Pavlov	3	...
,, .. ,, *lamplughi*, Pavlov	3	...
,, .. ,, *ramulicosta*, Pavlov	3	...
.. .. ,, *beani*, Pavlov	3	...
.. .. ,, *triplodiptychus*, Pavlov	3	...
.. .. ,, *polyptychus*, Key	3	...
.. .. = *Craspedites*) *fragilis*, Trautsch.	3	...
.. .. ,, cf. *subditus*, Trautsch.	3	...
.. .. ,, *okensis*	3	...
,, ,, ,, *plicomphalus*	3	...
.. (*Hoplites*) *regalis* (Bean) Pavlov	3	...
.. ,, *amblygonius*, N. and U. (*A. noricus*)	3	...
,, ,, *hystrix*, Phil.	3	...
.. ,, *roubandi*, d'Orb.	3	...
.. ,, *heteroptychus ?* Pavlov ...	3	...
,, ,, *oxygonius*	3	...
,, ., sp.	3	...
,. *oxynoticeras* cf. *catenulatum*, Fischer ...	3	...
,, *gravesianus*, d'Orb. (*O. keyserlingi*, N. and U.)	2	...
,, *noricus*, Schloth. (and varieties) ...	2	...
,, *rotula* (*kashpuricus*, Trautsch.) ...	2	...
Nautilus plicatus, Sow.	1	...
,, *pseudo-elegans* d'Orb.	1	...
,, *radiatus*, Sow.	1	...
Belemnites lateralis, Phil.	3, 2, 4	...
,, *russiensis*, d'Orb.	3	...
,, *subquadratus*, d'Orb.	3	...
,, *explanatoides*, Pavlov	3	...
,, *explanatus ?* Phil.	3	...
,, *absolutus*, Fischer	3	...
Crioceras (*Ancyloceras*) *grande*, Forbes sp.	1	...
,, ,, sp.	2	...
,, ,, sp.	2	...
GASTEROPODA.		
Aphorrhais sp. (*Rostellaria*, Phillips)	1, 4	...
Avellana (*Auricula*) *obsoleta*, Phil.	2, 1	...
Rostellaria parkinsoni, Phil. non Sow.	1, 4	...

NAME.	Speeton.	Knapton.
Rostellaria bicarinata, Leym.	1, 4	...
Cerithium clementinum var. d'Orb.	1, 9	...
Turritella lævigata, Leym.	1, 4	...
Solarium ? tabulatum, Phil.	1, 4	...
Trochus pulcherrimus, Phil. sp.	1, 4	...
,, *granulatus*	1, 4	...
Delphinula ? sp. (*inconspicua*, Phillips)	1, 4	...
Emarginula neocomiensis, d'Orb.	1, 4	...
Dentalium ellipticum ? Sow. (casts)	1, 4	...
Pleurotomaria sp.	3	...
LAMELLIBRANCHIATA.		
Ostrea leymeriei, d'Orb.	1	...
,, *frons*, Parkinson	1	...
,, sp.	2	...
Exogyra sinuata, Sow. (normal form)	1, 2	...
,, *parvula*, Leym.	1	...
,, sp. nov.	1, 2, 3	...
Plicatula placunea, Lam.	1, 5	...
Avicula inæquivalvis, Sow. = (*Pteria cornueliana*)	1, 2, 4	...
Placunopsis sp.	4, 1	...
Pecten elongatus, Lam.	1, 4	...
,, *orbicularis*, Sow.	1, 4	...
,, *cinctus*, Sow.	1, 4, 3	...
,, *interstriatus*, Leym.	1, 4	...
,, *striato-punctatus*, Römer	1, 4	...
Lima sp. nov.	1	...
,, sp. nov.	1	...
,, *undata*, Deshayes	1	...
,, *elegans*, Duj.	1	...
Inoceramus venustulus	1	...
,, *concentricus*, Sow. (small var.)	1	...
,, *imbricatus*	1	...
Pinna gracilis, Phil.	4, 1	...
Arca sp. (casts)	2	...
Nucula ovata, Leckenby, Phillips (*planata*, Deshayes)	2, 6	...
,, *subrecurva*, Phil.	2, 6	...
,, *lamplughi*, H. Woods	5	...
,, *obtusa*, Sow.	2	...
,, sp. (casts)	2	...
Leda spathulata, Forbes (*L. pandata*)	2	...
,, *seeleyi*	6	...
,, *scapha*, d'Orb.	6	...
Corbis sp.	2	...
Astarte senecta	5	...
,, (*Eriphyla*) *lævis*, Phil.	5	...
,, *laticosta*, Deshayes	4	...
Pteria (*Oxytoma*) *cornueliana*, d'Orb. = *A. vicula inæquivalvis* (G. W. Lamplugh)	5	...
Isocardia angulata, Phil.	4, 2	...
,, *?* sp.	2	...
Trigonia spinosa, Park.	4, 2	...

NAME.	Speeton.	Knapton.
Mya ? phaseolina, Phil.	2	...
Thetis sowerbyi, Römer (var. *major*)	2	...
,, ,, ,, (var. *minor*)	2	...
Protocardia sp.	5	...
Panopœa plicata	2	...
,, *neocomiensis*, Desh. sp.	2	...
,, *gurgitis*	13	...
Thracia phillipsii, Römer ? var.	2	...
,, *depressa*, Sow.	2	...
,, sp. (var. of *phillipsii*)	2	...
Pholadomya martini, Forbes	2	...
,, (sp. two rare)	2	...
,, *speetonesis*	13	...
Gervillia anceps, Desh.	4	...
Perna mulleti, Desh.	4, 5	..
,, *imbricata*	4	...
,, *venustula*	4, 1	...
Pholas (= *Martesia*) *constricta*, Phil.	2, 13	...
Lithodomus sp.	2	...
Teredo sp.	2	...
BRACHIOPODA.		
Terebratula depressa, Lam.	1, 2	...
,, *hippopus*, Römer (Judd.)	1, 2	...
,, *sella*, Sow.	1, 2	...
Terebratulina striata var. *pentagonalis*, Wahl.	1, 2	...
,, *martiniana*, d'Orb.	4	4
Rhynchonella sulcata, Park.	1	...
,, *lineolata*, Phil. sp.	1	...
,, sp.	1	...
Lingula truncata, Sow.	4, 1	...
Discinia sp. nov.	1	...
ECHINODERMATA.	1, 2, 4	...
Cidaris sp.	1	...
Pseudodiadema sp.	4	...
Toxaster argillaceus, Phil.	1	...
,, *complanatus*, Ag.	2, 4	...
Pentacrinus annulatus ? Römer	1	...
,, *angulatus*, Römer	1	...
,, sp.		
ACTINOZOA.		
Coral growing on *Serpula*	2	...
Lichenopora	2	...
Trochocyathus conulus, Phil.	1, 4, 12	...
,, *? calcaratus*, Tomes.	12	...
,, *wiltshirei*, Duncan	12	...
Smilotrochus cylindricus, Duncan	12	...

NAME.	Speeton.	Knapton.
CRUSTACEA.		
? *Meyeria vectensis* (*ornata*), Phil.	1, 2, 3	...
Obscure crustacean remains	1	...
Cirripede plate	1	...
Wood	3	...
COPROLITE BED (MR. LAMPLUGH).		
CEPHALOPODA.		
Ammonites (*Olcostephanus* = *Virgatites*) cf. *panderi*, d'Orb.	3	...
,, ,, ,, cf. *scythicus*, Mich.	3	...
,, ,, ,, cf. *chernuishevi*, Mich.	3	...
,, ,, ,, cf. *dorsoplanus*, Mich.	3	...
Belemnites cf. *absolutus*, Fischer	3	...
,, *magnificus*, d'Orb.	3	...
COPROLITE BED (Messrs. LECKENBY AND JUDD, Q.J.G.S., 1868).		
REPTILIA.		
Plesiosaurus sp.	1	...
Saurian remains	1	...
PISCES.		
Fish remains	1	...
CEPHALOPODA.		
Ammonites gigas, Niet.	1	...
,, *rotundus*, Sow.	1	...
LAMELLIBRANCHIATA.		
Lucina portlandica, Sow.	1	...
Arca sp. (casts)	1	...
Nucula sp. (casts)	1	...
Lithodomus (crypts)	1	...
Wood	1	...

KIMERIDGE CLAY.

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NAME.	Speeton.	Other Places.
REPTILIA.		
Plesiosaurus sp.	...	South Cave. 6
Pliosaurus sp.	5	...
Ichthyosaurus thyreospondylus	6	...
,, sp.	5	...
Steneosaurus sp.	4, 8	...
PISCES.		
Eurypoma egertoni, Ag.	5, 7	...
Gyrodus cuvieri, Ag.	5	...
Fish discovered by Mr. Danford (belonging to the *Eugnathidæ*)	4	...

NAME.	Speeton.	Other Places.
CEPHALOPODA.		
Belemnites troslayanus, d'Orb.	4, 5, 1	...
,, *porrectus*, Phil.	4	...
,, *puzosi*, d'Orb.	4	...
,, *obeliscoides*, Pavlov	4	...
,, *magnificus*, d'Orb.	4	...
,, aff. *magnificus ?*	4	...
,, cf. *absolutus*, Fischer	4	...
,, sp. ?	4	...
,, sp. ?	4	...
,, *oweni*, Pratt	5	
,, *nitidus*, Doll.	5, 1	Elloughton. 5
,, *lateralis*, Phil.	5	South Yorks. 5
,, *abbreviatus*, Mill.	5	N. Grimston. 5
Ammonites (Perisphinctites) lacertosus, Del. F. = *A. biplex*, Sow.	1,2,3,4,7,8	Settrington. 5
,, (*Cardioceras*) *alternans*, von Buch....	1	N. Grimston. 5
,, ,, *cordatus*, Sow. ...	5	Acklam Leavening. 5
,, *berryeri*, Lesueur	1, 5, 2	Settrington.
,, (*Hoplites*) *eudoxus* = *A. evalidus* ...	4	5
,, ,, *pseudomutabilis*, Loriol	4	...
,, ,, *subundoræ*, Pavlov ...	4	...
,, (*Olcostephanus* = *Virgatites*) cf. *miatchkoviensis* (Michel.)... ...	4	N. Grimston.
,, *eudoxus*, d'Orb. = *Hoplites* ...	5	5
,, *eumelus ?* d'Orb.	5	N. Grimston. 5
,, *longispinus*, Sow.	5, 1	...
,, *marantianus ?* d'Orb.	5, 1, 2	...
,, *mutabilis*, Sow.	5, 2	Kirby Misperton. 1 N. Grimston. 5
,, *plicomphalus*, Sow.	5	Kirby Moorside. 1
,, *rotundus*, Sow.	5	N. Grimston. 5
,, *trifidus*, Sow.	5	...
,, *triplicatus*, Sow.	5, 1, 2	...
,, *jo ?* d'Orb.	5, 1, 2	N. Grimston.
,, *acanthicus*	...	5
,, *gravesianus*, d'Orb.	5	...
Ancyloceras sp.	...	...
LAMELLIBRANCHIATA.		
Avicula ædilignensis, Blake	5	...
,, *expansa*, Phil.	5	...
Exogyra nana, Sow.	5, 1, 2	...

NAME.	Speeton.	Other Places.
Exogyra virgula, Defr.	5, 2	...
,, *sinuata,* Sow. (normal form)	2	
Ostrea deltoidea, Sow.	5	**Elloughton.** 5 **Welton.** 1
,, *gibbosa,* Lesueur	5	...
,, sp.	2	...
Pecten subtextorius, Münst.	5	...
,, sp.	2	...
Pinna granulata, Sow.	5, 1, 2	...
Astarte lineata, Sow.	5	...
Cardium striatulum, Sow.	5, 2	...
Ceromya excentrica, Ag.	5, 1, 2	...
Cucullœa sp.	5	...
Leda sp.	5, 1, 2	...
Lucina minuscula, Blake	5	...
,, *portlandica,* Sow.	5	...
Modiola bipartita, Phil. (non Sow.)	5, 2, 1	...
Myacites oblatus, Sow.	5	...
,, sp.	5, 2	...
Thracia depressa, Sow.	5, 1, 2	...
Pholadomya decussata, Phil.	5, 2, 7	...
Anatina minuta, Blake	3	...
Inoceramus sp.	2	...
Plicatula sp.	2	...
Gasteropoda.		
Alaria trifida, Phil.	5	...
,, *mosensis,* Buvig.	5	...
Brachiopoda.		
Rhynchonella inconstans, Sow.	2, 5, 1	**Knapton.** 1
,, sp.	2, 5	...
,, *subvariabilis ?* Dav.	5	...
Discinia humphriesiana, Sow.	5	...
,, *latissima,* Sow.	2, 5	...
Lingula ovalis, Sow.	5, 2, 1	...
Annelida.		
Serpula tetragona, Sow.	5	...
Crustacea.		
Pollicipes hausmanni, K. and D.	5	...
Echinodermata.		
Pentacrinus sp.	2, 5	...
Porifera.		
Sponges	2	...
Wood	2	...

PORTLANDIAN.

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FOSSILS OF THE PORTLANDIAN.

NAME.	Speeton.	Knapton.
REPTILIA.		
Plesiosaurus sp.	1	...
PISCES.		
Fish remains	1	...
CEPHALOPODA.		
Belemnites sp.	1	...
,, *lateralis*	2	...
Ammonites *gigas*, Niet.	1, 3	...
,, *giganteus*, Sow. ?	1, 3	...
,, *gravesianus*, d'Orb.	1	...
,, *irius*, d'Orb.	1, 3	...
,, *rotundus*, Sow.	1	...
,, (*Hoplites*) *deshayesi* (*knaptonensis*)	...	2
,, (,,) *amblygonius* (=*noricus*), N. & U	...	2
,, *Perisphinctes lacertosus*, D. and F. = *A. biplex*, Phil.	3	...
LAMELLIBRANCHIATA.		
Avellana obsoleta, Phil.	2	...
Avicula obsoleta, Phil.	2	...
Exogyra sinuata, Sow.	2	...
Pecten lens, Sow. var. *morini*, de Lor.	2	...
Arca sp.	2, 1	...
Astarte senecta	2	...
Nucula sp.	2, 1	...
Lucina portlandica, Sow.	3, 2, 1	...
Lithodomus sp.	2, 1	...
BRACHIOPODA.		
Rhynchonella inconstans, Sow.	2	...
Lingula ovalis, Sow.	2	...
Wood	2, 1	...

CORALLIAN ROCKS.

Including Upper Calcareous Grit, Coral Rag and Upper Limestone, Middle Calcareous Grit, Lower Limestone.

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4. Collected by G. LETHER, now in Hull Museum.
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CORALLIAN ROCKS.

Embracing the Zones of *Ammonites perarmatus* and *Ammonites plicatilis*.

NAME.	North Grimston.	Settrington.	Langton Wold.
REPTILIA.			
Pliosaurus teretideus, Owen M.S. = *P. brachydeirus*, Owen (teeth)	1, 2, 3, 4	...	...
Teleosaurus sp. (teeth)	1, 3, 4	...	...
PISCES.			
Hybodus cf. *grossiconus*, Ag. (teeth) ...	1, 3, 4	...	...
„ *obtusus*, Ag. (teeth)	1, 3, 4	...	...
Gyrodus punctatus, Ag.	1, 3	...	...
Lepidotus sp. (scales and teeth)	1, 3, 4	...	...
Ischyodus egertoni, Ag.	3	...	...
CEPHALOPODA.			
Ammonites (*Perisphinctes*) *varicostatus*, Buck....	1, 2	...	1, 2
„ „ *decipiens*, Sow.	1, 2	...	1, 2
„ „ *plicatilis*, Sow.	1	...	...
„ „ *biplex*, Sow. ...	1	...	...

NAME.	North Grimston.	Settrington.	Langton Wold.
Ammonites (*Cardioceras*) *vertebralis*, Sow.	1	...	...
,, ,, *alternans*, von Buch.	1	...	...
,, ,, *cortonensis*, B. & H.	1	...	...
,, ,, *cordatus*	...	1	...
,, *berryeri*, Lesueur	1, 2	...	...
,, *achilles ?*	...	1	...
,, *trifidus*	1, 2	...	1, 2
Nautilus aganiticus, Schloth.	1, 2	...	1, 2
Belemnites abbreviatus, Miller	1, 3, 4	1	1
,, *nitidus*, Dollf. (*B. explanatus*, Phil.)	...	...	1
,, cf. *owenii*, Pratt	...	1	...
,, *semisulcatus ?* Münster.	1, 2	...	1, 2
,, *hastatus ?*	2	...	1, 2
GASTEROPODA.			
Purpuroidea nodulata, Y. and B.	1, 4	1	1
Natica buccinoidea, Hud.	1	...	1
,, *clymenia*, d'Orb.	1, 3, 4	...	...
,, *clytia*, d'Orb.	1, 3, 4	...	...
Chemnitzia heddingtonensis Sow.	1	1, 3	1
,, *pollux*, d'Orb.	1	...	...
,, *langtonensis*, B. and H.	...	...	1
Nerinæa moreana, d'Orb.	1	...	...
,, *römeri*, Goldf.	1, 3	1, 3	1
,, *allongiuscula ?* Bean	1	...	1
,, *fasciata*	...	1	...
Littorina muricata, Sow.	1, 3	1	1
,, ,, var. *pulcherrima*, Dollf.	1, 4	...	...
,, (*Encyclus*) *buvignieri*, d'Orb.	1	...	...
Nerita sp	1	...	...
Neritopsis guerrei, H. and D.	1, 4	...	...
,, *decussata*, Münster.	1	...	...
Trochus sp.	1	...	...
Turbo corallensis, Buvig.	1. 2, 3, 4	...	1
,, *funiculatus*, Phil.	1, 4	1	...
,, *erinus*, d'Orb. = *Turbo lævis*, Buvig.	1	...	1
,, *pellati*, De Lor. = (*Delphinula* sp.)	1, 4	...	1
Pleurotomaria reticulata, Sow.	1, 3	...	1
,, *agassizii*, Münster.	1	...	...
Trochotoma tornatilis, Phil.	1, 3	...	1
Alaria sp. (cf. *tridactyla*), Buvig.	1	...	1
Patella rugosa, Sow.	1, 2	...	1, 2
LAMELLIBRANCHIATA.			
Ostrea duriuscula, Phil.	1	...	...
,, *bullata*, Sow. (*Gryphæa*)	...	...	1
,, *subgibbosa*, B. and H.	1	...	...
,, *gregaria*, Sow.	1	1	1
Exogyra nana, Sow.	1, 2	1	1, 2
,, sp.	1	...	...

NAME.	North Grimston.	Settrington.	Langton Wold.
Anomia radiata, Phil.	1	...	...
Plicatula sp. (cf. *fistulosa*, L. and M.)	1	...	...
Pecten vimineus, Sow.	1, 2	...	1, 2
,, *inæquicostatus*, Phil.	1	1	...
,, *demissus*, Phil.	1, 2	...	1, 2
,, *midas*, d'Orb.	...	...	1
,, *intertextus*, Römer	1	1	...
,, *lens*, Sow.	1, 2	...	1, 2
,, *qualicosta*, Et.	1	1	...
,, *fibrosus*	1, 2	1	1, 2
Hinnites sp. near to *H. fallax*, Dollf.	1	...	...
Lima læviuscula, Sow. var.	1	...	1
,, *rigida*, Sow.	1	...	1
,, *pectiniformis*, Schloth.	1	...	1
,, *rudis*, Sow.	1	...	1
,, *elliptica*, Whit. var.	1	...	1
,, *subantiquata*, Römer	1	...	1
Avicula ovalis, Phil. var. *obliqua*	...	...	1
,, *ædilignensis*, Blake	1	...	...
Trichites plottii	1	...	...
Mytilus ungulatus, Y. and B.	1	...	...
Modiola inclusa, Phil.	1	...	1
,, *cancellata*, Römer	1, 2	...	1, 2
Arca quadrisulcata, Sow.	1	...	1
,, *pectinata*, Phil.	1	...	1
Perna subplana, Et.	1	...	...
,, *mytiloides*, Lam.	1, 2	...	1, 2
Cucullæa elongata	1	...	...
Nucula sp.	1	...	1
Trigonia costata	1, 2	...	...
,, *clavellata*, Sow.	1	...	1, 2
Protocardium isocardioides, B. and H.	1	...	1
Unicardium depressum	...	1	...
Cardium debilatum ? De Lor.	1, 2	...	1, 2
Tancredia curtansata, Phil.	...	1	...
,, cf. *planata*, M. and L.	...	1	...
Lucina aliena, Phil.	1	1	...
,, cf. *aspera*, Buvig.	1	...	1
,, *substriata*, Römer	1	...	...
Opis virdunensis, Buvig.	1	...	1
,, *lunulata*, Römer	1	...	1
,, *phillipsii*	...	1	...
Astarte rhomboidalis, Phil.	1	...	1
,, *ovata*, Smith	1	1	1
Homomya crassiuscula, L. and M.	1	...	1
,, *tremula*, Buvig.	1	...	...
,, (*grimstonensis*)	1	...	...
Thracia depressa, Sow.	1	...	1
Pholadomya cf. *concentrica*, Römer	1	...	1
Panopæa gigantea	1	...	1
Myacites sp.	1	...	1
Pleuromya sp. (*tellina*)	1, 2	...	1, 2
,, *voltzii*, Ag.	1, 2	...	1, 2

NAME.	North Grimston.	Settrington.	Langton Wold.
Goniomya v-scripta, Sow.	1	...	...
,, *marginata*, Ag.	...	...	1
,, *literata*	1, 2	1	1, 2
Corbicella sp.	1	1	...
Pinna sp.	1, 2	...	1, 2
Gryphæa subgibbosa	1, 2	...	1, 2
Gervillia angustata, Römer	1, 2	...	1, 2
BRACHIOPODA.			
Terebratula insignis var. *maltonensis*, Oppel	1	...	...
,, *gesneri*	3	...	...
Discinia elevata, Blake	1, 2	...	1, 2
ANNELIDA.			
Serpula squamosa, Phil.	...	...	1
,, *intestinalis*, Phil.	1, 2	...	1, 2
,, *tetragona*, Sow.	1, 2	...	1, 2
ECHINODERMATA.			
Cidaris florigemma, Phil.	1, 3, 4	1, 3, 4	1, 2
,, *smithii*, Wright	1	1, 3, 4	1
Hemicidaris intermedia, Flem.	1, 2, 3, 4	1	1
Pseudodiadema hemisphæricum, Ag.	1, 2, 3, 4	1, 3	1
Stomechinus gyratus, Ag.	1	...	...
Pygaster umbrella, Ag.	1, 4	...	1
Collyrites bicordata, Leske.	1	...	1
Echinobrissus scutatus, Lam.	1, 3, 4	...	1
Millericrinus echinatus, Goldf.	1, 3	1, 3, 4	...
Apiocrinus polycyphus, Merian.	1	...	...
Pentacrinus sp.	1	...	...
ACTINOZOA.			
Stylina tubulifera, Phil.	1	...	...
Montlivaltia dispar, Phil.	1, 3, 4	...	...
Thecosmilia annularis, E. and H.	1, 3, 4	1, 3	...
Goniocora socialis, Römer	...	...	1
Isastræa explanata, Phil.	1, 3, 4	1, 3, 4	...
Thamnastræa concinna, Goldf.	1, 3, 4	1, 3	...
,, *arachnoides*, Park.	1, 3, 4	3	...
Latimæandra decorata	...	...	6
Protoseris waltoni, E. and H.	...	6	...
PORIFERA.			
Holcospongia glomerata, Quenst.	...	...	5, 4
Raxella perforata, Hinde	...	5	...
Corynella chadwicki, Hinde	...	5	5
,, *langtonensis*, Hinde	...	...	5, 4

OXFORD CLAY.

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2. KEEPING and MIDDLEMISS. "Sections at Cave, Yorkshire," Geological Magazine, 1883, p. 215.
3. T. SHEPPARD. "Geological Rambles in East Yorkshire," 1903.
4. Collected by H. C. DRAKE.

OXFORD CLAY.

NAME.	South Cave.
REPTILIA.	
Plesiosaurus sp.	1, 2, 3
CEPHALOPODA.	
Ammonites (*Cosmoceras*) *elizabethæ*	1
,, ,, *comptoni*	1
Belemnites hastatus	1, 2
,, *owenii*	1, 2, 3, 4
,, *abbreviatus*	1, 2, 4
LAMELLIBRANCHIATA.	
Ostrea dilatata = *Gryphœa dilatata*	1, 2, 3, 4
,, *gregaria*	1
Pecten sp.	1
Wood	2, 4

KELLAWAYS ROCK.

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2. Collected by T. Sheppard, and now in Hull Museum.

3. Collected by H. C. Drake.

4. Professor Phillips. "Geology of Yorkshire Coast," 3rd edition, 1875.

5. C. Fox Strangways. "The Jurassic Rocks of England." Memoirs Geological Survey, Vol. I., Yorkshire, 1892.

6. "Geology of Country between York and Hull," Memoirs of Geological Survey, 1886.

Fossils of the Kellaways Rock.

Name.	Drewton Cutting.	Other Places.
Reptilia.		
Cryptocleidus sp.	2	2, Brough Mill Hill
Plesiosaurus sp.	1	...
Cephalopoda.		
Ammonites (*Kepplerites*) *gowerianus*, Sow.	1, 3	...
,, ,, *calloviensis*, Sow.	3, 2	...
,, ,, *modiolaris*, Hind	1, 2, 3	...
,, ,, *duncani*, Sow.	1	...
,, (*Siemiradzkia*) *königi*, Sow.	1, 2, 3	...
,, (*Quenstedtoceras*) *Mariæ*, d'Orb.	1	...
,, (*Macrocephalites*) sp. Schloth.	3, 2	...
,, *sublævis*	6	...
Belemnites owenii, Pratt	1, 2, 3	3, 5, Newbald
,, ,, varieties	2, 6	2, Brough

NAME.	Drewton Cutting.	Other Places.
GASTEROPODA.		
Turbo sulcostomus, Phil.	1, 4	...
,, sp.	1, 2	...
Cerithium culleni, Leckenby	1	...
,, sp.	1, 2	...
Alaria bispinosa, Phill.	3, 1	...
Pleurotomaria sp.	1	...
BRACHIOPODA.		
Rhynchonella socialis, Phil.	1, 2, 3	2, 5, Newbald
Waldheimia ornithocephala, Sow.	1	...
LAMELLIBRANCHIATA.		
Gryphœa bilobata, Sow.	1, 2, 3	2, 5, 6, Newbald
,, *bullata*	...	2, Brough
Pecten demissus, Phil.	1	...
,, *lens*, Sow.	1, 2, 3	...
,, *fibrosus*, Sow.	1, 2, 3	...
,, large ribbed species	1	...
Avicula braamburiensis, Phil.	1	...
,, *inæquivalvis*, Sow.	1, 3	...
,, *expansa*	4	...
Perna rugosa, Goldf.	1	...
Pinna mitis, Phil.	1, 4	...
Modiola sp.	1, 2, 3	2, Newbald
,, *cuneata*, Sow.	4	...
,, *pulchra*, Phil.	1	...
Trigonia rupellensis, d'Orb.	1	2, Newbald 2, Brough
Cucullœa corallina, Damon	1	...
,, sp.	1	...
,, *concinna*	4	...
Arca sp.	1	...
Cardium crawfordii, Leckenby	1	...
,, *cognatum*, Phil.	1	...
Isocardia minima	1, 2, 3	...
,, sp.	1	...
Cyprina (two or three species)	1, 4	...
Astarte ungulata ? Lycett.	1	...
,, *carinata*, Phil.	4	4, Newbald
,, sp., small ribbed species	1	...
Unicardium depressum, Phil.	1	...
Corbicella ovalis ? Phil. (*lævis*)	1, 4	...
Pholadomya ovulum, L. and M. (*ovalis*, Sow.)	1	...
,, *heraulti*, Ag.	1	...
Gresslya peregrina, Phil.	1, 3	...
Goniomya v-scripta, Sow.	1, 2	...
Anatina undulala, Sow.	1	...
Myacites decurtatus, Phil.	1	2, 5, Newbald
,, sp.	1	...

THE MILLEPORE BED.

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1. KEEPING and MIDDLEMISS. "Sections at Cave, Yorkshire," Geological Magazine, 1883.
2. T. SHEPPARD. "The Geology of Brough, East Yorkshire," "Naturalist," 1901, and "Geological Rambles in East Yorkshire," 1903.
3. Professor J. PHILLIPS. "The Geology of the Yorkshire Coast," 3rd edition, 1875.

FOSSILS OF THE MILLEPORE.

NAME.	South Cave.	Brough.
PISCES.		
Hybodus sp.	2	...
GASTEROPODA.		
Chemnitzia sp.	2	...
Cerithium sp.	2	...
Turbo sp.	2	...
LAMELLIBRANCHIATA.		
Lima pectiniformis, Schloth.	2, 1	2
Trigonia conjungens, Lycett.	2, 1	...
Avicula sp.	2	...
Modiola sp.	2	...
Pinna cuneata	3	2
Pecten lens	2	2
,, *demissus*	2	2
Myacites sp.	2	2
Cardium sp.	2	2
BRACHIOPODA.		
Rhynchonella crossi	2	2
Terebratula sp.	2	2
ANNELIDA.		
Serpula sp.	2	...
ECHINODERMATA.		
Hyboclypus sp.	1	...
Echinoderm remains	2	...
Pentacrinus sp.	2	...
POLYZOA.		
Spiropora (*Cricopora*) *straminea*	2, 1, 3	...

THE LIAS.

Upper, Middle, and Lower.

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2. C. FOX STRANGWAYS, "The Jurassic rocks of Yorkshire," Vol. I., 1892, Memoirs of the Geological Survey.
3. Collected by H. C. DRAKE.
4. T. SHEPPARD. "The Geology of Brough," "Naturalist," May, 1901, "Geological Rambles," 1903.
5. KEEPING and MIDDLEMISS. "Sections at Cave, Yorkshire," Geological Magazine, 1883.
6. Collected by T. SHEPPARD.
7. DAKYNS, FOX STRANGWAYS, and CAMERON. "Geology of Country between York and Hull," Memoirs of Geological Survey, 1886.

FOSSILS OF THE LIAS.

NAME.	Market Weighton District.	Other Localities.
REPTILIA.		
Ichthyosaurus intermedius, Conybear (L.L.*	1, 2, N. Cliff	1, Givendale
,, sp.	...	,,
Plesiosaurus rugosus (tooth), Owen (L.L.	1, Cliff	...
,, *brachycephalus*, Owen (L.L.	1 ,,	...
,, sp. *undet* (L.L.)	6 ,,	...
PISCES.		
Dapedius sp. (L.L.)	1, 2, Cliff	...
Hybodus minor, Ag. (L.L.)	1, 2 ,,	...
Acrodus minimus, Ag. (L.L.)	1, 2	...
CEPHALOPODA.		
Ammonite (*Psiloceras*) *planorbis*, Sow.	1, 2, Cliff	...
,, ,, *johnstone*, Sow.	1, 2, 4 ,,	...
,, (*Schlotheimia*) *angulata*, Schloth	1, 2	1, Millington 2, Ridingsbeck

*L.L. = Lower Lias.

NAME.	Market Weighton District.	Other Localities.
Ammonite (*Arietites*) *macdonnelli*, Portlock	...	1, Warter
,, ,, *conybeari*, Sow.	1, 2 Cliff ...	...
,, ,, *bucklandi*, Sow.	...	1, Millington
,, ,, *sauzeanus*, d'Orb.	...	1 ,,
,, ,, *semicostatus*, Y. & B.	...	1, Nunthorpe
,, (*Ægoceras*) *gagateum*, Y. and B.	1, Cliff ...	1, Warter
,, ,, *obsoletum*, Simp.	...	1, Londesboro'
,, ,, *densinodum*	...	1, Warter
,, ,, *longipontinum*, Oppel.	1, 2 Cliff ...	1, Millington
,, ,, *nanum ?* Martin	1 ,, ...	...
,, ,, *armatum*, Sow.	...	1, Garrowby and Warter
,, (*Oxynoticeras*) *oxynotum*, Quenst.	1, Cliff ...	...
,, (*Amblycoceras*) *capricornus*	4, 5, Cliff ...	3, Everthorpe
,, (*Amaltheus*) *spinatus*, Burg.	1, 4, 5, Mkt. Weighton	1, Hotham
,, (*Stephanoceras*) *annulatum*, Sow.	...	1, Millington
,, (*Lytoceras*) *cornucopia*, Y. and B.	...	1 ,,
,, (*Harpoceras*) *serpentinum*, Rein.	...	1 ,,
,, (*Dachylioceras*) *commune*, Sow.	...	1, Sancton
,, (*Hildoceras*) *bifrons*, Brug.	...	1 ,,
,, (*Coroniceras*) *bisulcatus*, Brug.	...	2, Ridingsbeck
,, *mangenesti ?*	...	2, ,,
Nautilus striatus, Sow.	1, 2, 4, Cliff ...	...
Belemnites infundibulum, Phil.	1 ,, ...	1, Warter
,, *acutus*, Miller	1, Mkt.W.dist.	1, Millington
,, *penicillatus*, Sow.	...	1, Warter
,, *araris*, Dumont.	...	1 ,,
,, *breviformis*, Voltz.	1, Mkt.W.dist.	1, Hotham
GASTEROPODA.		
Hydrobia krausseana, Dunker. (L.L.)	1, Mkt.W.dist.	...
Euomphalus liasianus = *Discohelix liassinus*, Dunker	1 ,, ...	...
Actæonina fragilis, Dunker (L.L.)	1, 2 ,, ...	...
Discohelix striata (L.L.)	...	...
,, *semiclausa* (L.L.)	...	...
,, *liassinus*, Dunker (L.L.)	2, Cliff ...	...
Pleurotomaria concava ? Martin (L.L.)	1, Mkt.W.dist	...
,, *obesula* (L.L.)	...	...
,, *similis* = *P. anglica*, Sow. (L.L.)	1, 4, 6, Cliff ...	1, Leppington
,, *concava*, Martin	2 ,, ...	...
Cryptænia solarioides, Sow. (L.L.)	1 ,, ...	1, Millington
,, *rotellæformis*, Dunker (L.L.)	1 ,, ...	...
,, *nucleus*, Terquem. (L.L.)	1 ,, ...	...
Phasianella morencyana, Piette (L.L.)	1 ,, ...	...
Turbo solarum, Piette (L.L.)	1 ,, ...	1, Millington
,, *tenuis*, Terquem. (L.L.)	1, 4, 2, 6 ,, ...	...
,, *philemon*, d'Orb. (L.L.)	1 ,, ...	...
Encyclus elegans, Münster. (L.L.)	1 ,, ...	...
,, *acuminatus*, C. and D. (L.L.)	1 ,, ...	...
Turritella dunkeri, Terquem.	1, ,, ...	...

NAME.	Market Weighton District.	Other Localities.
Chemnitzia transversa, Blake	1. Cliff	...
,, *unicingulata*, Terquem.	1 ,,	...
,, *blainvillei*, Münst.	...	1, Kirby Underdale
Cerithium gratum, Terquem.	1, Cliff	...
,, *semele*, d'Orb.	1 ,,	...
Hydrobia solidula, Dunker.	...	1, Warter
LAMELLIBRANCHIATA.		
Avicula inæquivalvis, Sow.	1, 3, Cliff	...
,, *pattersoni*, Tate	1 ,,	...
Monotis fallax, Pflücker (*Avicula*)	1,2 ,,	...
Ostrea liassica, Strickland	1,3,2,4 ,,	1, Acklam 3, Hotham
,, *irregularis*	1 ,,	...
,, *ungula*, Münster.	1 ,,	...
,, *semiplicata*, Münst.	1 ,,	...
,, *sportella*, Dumort ?	...	1, Warter
,, *obliquata*, Sow.	...	1, Kirby Underdale
,, *submargaritacea*, Brauns.	1, Cliff	1, Hotham
Pecten æqualis, Quenst.	1,2 ,,	...
,, *pollux*, d'Orb.	1,2 ,,	...
,, *textilis*, Münster.	1 ,,	...
,, *punctatissimus*, Quenst.	1 ,,	...
,, *textorius*, Schloth.	1 ,,	...
,, *calvus*, Goldf.	1, Mkt. W.	...
,, *priscus*, Schloth.	1 ,,	1, Warter
,, *hehlii*	...	1, Kirby Underdale
,, sp.	5, Mkt. W.	1, Everthorpe
,, *lunularis*, Römer	1, ,,	1, Hotham
,, *æquivalvis*, Sow.	1, ,,	1 ,,
,, *verticillus*	...	1 ,,
,, *sublævis*	7, Mkt. W.	...
Astarte obsoleta, Dunker.	1, 2, Cliff	1, Millington
,, *oppeli*	...	1 ,,
,, *striato-sulcata*, Römer	...	1, 3, Hotham
Cardinia ovalis, Stutchberry	1,2,3,Mkt. W.	1, Millington
,, *listeri*, Sow.	1, 4, Common	1, Common
,, *crassiuscula*, Sow.	1 ,,	1,Millington, &c.
,, *deshayesi*, Terquem.	1 ,,	...
,, *desoudini*, Terquem.	1 ,,	...
,, *listeri* var. *hybrida*	1, Mkt. W.	...
Protocardium phillipianum, Dunker.	1, 2, Common	1, Common
,, *oxynoti*, Quenst.	1, Mkt. W.	1, Warter
,, *truncatum*, Sow.	1 ,,	...
Lima gigantea, Sow.	1, 4, 3 ,,	1, Millington & Pocklington
,, *terquemi*, Tate	...	1 ,,
,, *succinata*, Schloth.	1, Mkt. W.	...
,, *punctata*, Sow.	1 ,,	...

NAME.	Market Weighton District.	Other Localities.
Lima pectinoides, Sow.	1 Mkt. W.	2, Ridingsbeck
,, *hettangiensis*, Terquem.	...	1, Millington & Pocklington
Limea blakeana, Tate	1, Cliff	...
,, *acuticosta*, Münster.	1, Mkt. W.	1, Kirby Underdale
Macrodon hettangiensis, Terquem.	1, 2, Mkt. W.D and Cliff	...
,, *naviculus*, Terq. and Piette.	1, Cliff	...
,, *intermedius*, Simpson	...	1, Garrowby
,, *pulchellus*	...	1, Kirby Underdale
Modiola minima, Sow.	1, 2, Mkt. W. 4, 3, Cliff	1, 3, Leavening Acklam, and Hotham
,, *lævis*, Sow.	1, 2, Mkt. W.	...
,, *hillana*, Sow.	...	1, Millington
,, *numismalis*, Oppel.	...	1, Kirby Underdale
Pleuromya crowcombeia, Moore	1, 2, Mkt. W. 4, Cliff	1, 3, Hotham, Acklam, etc.
,, *ovata*, Römer	1, Mkt. W.	...
,, *costata*	1, Cliff	2, Ridingsbeck
Ceromya infraliassica, Terq.	1 ,,	1 ,,
Pholadomya glabra, Ag.	1,3 ,,	...
,, *ambigua*, Sow.	1, Mkt. W.	...
Gryphæa arcuata = G. incurva, Lam.	1, 3, Common	1, Common
,, *obliquata*, Sow.	1, Mkt. W.	...
Anomia alpina Wisch.	...	1, Millington
,, *striatula*, Oppel.	...	1, ,,
Plicatula liasina, Terq.	...	1 ,,
,, *spinosa*, Münst.	1, Mkt. W.	...
Perna infraliassica, Quenst.	1 ,,	...
Pinna hartmanni, Zieten.	1 ,,	...
,, *folium*, Y. and B.	...	1, Garrowby and Warter
Hippopodium ponderosum, Sow.	1, Mkt. W.	...
Leda renevieri, Oppel.	1 ,,	...
,, *texturata*, Terq.	1 ,,	...
,, *galathea*, d'Orb.	...	1, Warter
,, *minor*, Simpson	...	1 ,,
Cardita heberti, Terq.	1, Mkt. W.	1, Millington
Lucina limbata, Terq.	1 ,,	...
Saxicava arenicola, Terq.	1 ,,	...
Myoconcha inclusa, Terq.	...	1, Millington
,, *psilonoti*, Quenst.	1, Mkt. W.	...
Unicardium cardioides, Phil.	1 ,,	...
Monotis inæquivalvis, Sow.	1 ,,	...
Nucula cordata, Goldf.	...	1, Warter
Arcomya vetusta, Phil.	...	1, Warter and Kirby Underdale
,, *longa*, Buvig.	1, Mkt. W.	...
Gresslya intermedia. Simpson	1 ,,	...

NAME.	Market Weighton District.	Other Localities.
BRACHIOPODA.		
Waldheimia sarthacensis, d'Orb.	1, Mkt. W.	1, Garrowby
,, *resupinata*	5 ..	1, Everthorpe
Rhynchonella plicatissima, Quenst.	1 ..	1, Millington, etc
.. *furcillata*, von. Buch.	...	1, Kirby Underdale
,, *variabilis*, Schloth.	...	1, Warter
,, *tetrahedra*, Sow.	1, 5, Mkt. W.	1, Hotham
Terebratula punctata, Sow.	1 ,,	1 ..
.. *edwardsii*	7 ..	...
ANNELIDA.		
Galeolaria socialis, Goldf.	1, 3, Mkt. W.	...
Serpula plicatilis, Goldf.	1 ,,	...
Ditrypa capitata, Phil.	1 ,,	...
ECHINODERMATA.		
Cidaris edwardsii,* Wright	1, 2, Mkt. W.	9, Cliff
Hemipedina tomesii, Wright	1, 2 ..	...
Pentacrinus psilonoti, Quenst.	1, 2 ..	...
,, *britannicus*	2 ..	...
Holothuria sp.	1 ..	...
CRUSTACEA.		
Bairdia liassica, Brodie	1, 2, Mkt. W.	1, Millington, etc
,, *elongata*	...	1 ..
Cythere blakei, Jones	1, 2, Mkt. W.	...
,, *moorei*, Jones	1, 2 ..	...
.. *terquemi*, Jones	1, 2 ..	
,, *translucens*	1 ..	...
INSECTA.		
Libellula sp., Tate and Blake	1, Mkt. W.	...
Chauliodites minor, Blake	1, 2 ..	...
ACTINOZOA.		
Montlivaltia haimei, C. and D.	1, 2, Mkt. W.	1, Millington
,, *polymorpha*, Terq.	2 ,,	...
Septastræa excavata, From.	1, 2 ..	...
PLANTÆ.		
Alethopteris sp.	...	1, Givendale

NAME.	Market Weighton District.	Other Localities.
FORAMINIFERA.		
Cornuspira infirma, Strickland	1, Cliff	...
Miliola scheibersii, d'Orb.	1 ,,	...
Trochammina irregularis	1 ,,	...
Lituola globata	1 ,,	...
Lagena lævis, Montfort.	1 ,,	...
,, *natrii*	1 ,,	...
,, *elongata*, Ehrenburg	1 ,,	...
,, *ovata*, Terq.	1 ,,	...
Glandulina paucicosta, Römer	1 ,,	...
Lingulina tenera, Bornemann	1 ,,	1, Millington and Warter
,, *striata*	1 ,,	...
Nodosaria radicula, L.	1 ,,	1, Warter
,, *raphanus*, L.	1 ,,	...
,, *raphanistrum*, L.	1 ,,	...
,, *nitida*, d'Orb.	1 ,,	...
Dentalina funiculosa, Terq.	1 ,,	1, Warter
,, *burgundiæ*, Terq.	1 ,,	1 ,,
,, *communis*, d'Orb.	1 ,,	1, Millington
,, *breoni*, Terq.	1 ,,	...
,, *oligostegia ?* Terq.	1 ,,	1, Millington
,, *planata*	1 ,,	...
,, *pauperata*, d'Orb.	1 ,,	...
,, *brevis*, d'Orb.	1 ,,	...
,, *tecta*, Terq.	1 ,,	...
,, *nodosa*, d'Orb.	1 ,,	...
,, *monilis*, Cornuel.	1 ,,	Millington
,, *glandulosa*, Terq.	1 ,,	...
,, *nummulina*, Gümbel.	...	1, Millington
Marginulina raphanus, L.	1, Cliff	1, Warter
,, *picta*, Terq.	1 ,,	1, Millington
,, *römeri*, Reuss.	1 ,,	...
,, *depressa*	1 ,,	...
,, *unicostata*, Terq.	1 ,,	...
,, *? pauliniæ*, Terq.	1 ,,	...
Cristellaria pauperata, Jones and Parker	1 ,,	...
,, *recta*, d'Orb.	1 ,,	1, Millington
,, *major*, Bornemann	1 ,,	1, Warter
,, *cuspidula*, Ficht.	1 ,,	1, Millington and Warter
,, *bronnii*, Römer	1 ,,	1 ,,
,, *varians*, Bornemann	1 ,,	1 ,,
,, *globifera*	1 ,,	1 ,,
,, *rotulata*, Lam.	1 ,,	1 ,,
Flabellina rugosa, d'Orb.	1 ,,	...
Frondicularia complanata, Defr.	1 ,,	...
,, *sulcata*, Bornem.	1 ,,	...
,, *nodosaria*, Terq.	1 ,,	...
Polymorphina fusiformis, Römer	1 ,,	...
,, *compressa*, d'Orb.	1 ,,	...
,, *problema*, d'Orb.	1 ,,	...
,, *simplex* Terq.	1 ,,	...
,, *distincta*, Terq.	1 ,,	...
Pulvinulina elegans, d'Orb.	1 ,,	1, Millington

A BORING AT EAST HARLSEY.

BY EDWIN HAWKESWORTH.

(*Read 4th March,* 1909.)

East Harlsey is a village about five miles N.E. of Northallerton, at the foot of the western escarpment of the Hambleton Hills. The bore-hole was put down with the intention of obtaining a supply of water for the hall and village, but was stopped at a depth of 350 feet from the surface, owing to this object not being attained, though I have since been informed that some water is being yielded and used for outdoor purposes. The site is close to the church, between 300 and 350 feet above sea-level. As it is a little to the east of the assumed outcrop of the Rhætic beds beneath the drift, it seemed likely to furnish valuable information as to the exact thickness of these rocks, but, through a most unfortunate chapter of accidents, exact measurements could not be obtained. However, such information as was obtainable may be worth putting on record.

There is a bore-hole marked on the Geological Survey map, a few yards distant from this one, but it has not been possible to obtain details of the rocks passed through. Some of the old inhabitants of the village remember a boring being carried out many years ago, and the drillers went through two thick coal-seams !!! (Probably black shales.)

The cores in the boring now described got so mixed up, particularly the upper ones, and the shales weathered so rapidly in the very severe weather prevailing at the time, that a fully detailed section cannot be made, but the following is approximately correct :—

	Ft.	In.
1.—New soil, probably an old rubbish tip	2	9
2.—Good paved road, with apparently an older road beneath	1	1
3.—Hard shelly rock, variable in colour and texture, full of *Gryphæa incurva* ..	12	8
4.—Dark shales, with several hard bands ..	113	6

	Ft.	In.
5.—Soft dark limestone (?)	15	0
6.—No core, but water returned up bore-hole was reddish-brown, whilst material in sediment tube was dark-brown ..	12	0
7.—Various coloured marls, gypsum, and anhydrite (one piece of core 15 inches long, gypsum)	91	0
8.—Red and green marls (at 258 feet drill entered "rotten marl"; after passing through a few inches of hardish light-green rock at 270 feet the drill entered hard sandy marl)	22	0
9.—Marls	80	0

As to the geological position of these beds, No. 3 apparently represents the *Ammonites Bucklandi* zone of the Lias, of which the abundant and large-sized *Gryphœa* is characteristic. Further, Tate and Blake ("Yorkshire Lias," page 67) record shales belonging to this zone as exposed in the roadside near East Harlsey Church.

It was quite impossible to make out any succession in the beds constituting 4 and 5, owing to the mixing up of the cores, though the presence of large numbers of *Pleuromya* and *Cardinia*, both in the shales and harder layers, suggest the lowest beds of the Lias.

No. 6 may be said to represent the Rhætic beds. The core of 12 feet was lost, and, in going through it again, appears to have been ground up. However, the position, and the occurrence of *Avicula contorta* on such fragments as remained, leave little doubt that this view is correct. Immediately after this, at 157 feet down, the change was reported as being very abrupt.

The beds passed through from 157 feet to 350 feet appear to belong to the Keuper.

I have to express my very great indebtedness to Mr. F. G. Clements, engineer to the New England Boring Co. Ltd., of Walton, near Peterborough, for affording me the opportunity of recording this section.

A BORING AT SELBY.

BY EDWIN HAWKESWORTH.

I am further indebted to Mr. F. G. Clements, of the New England Boring Co. Ltd., for a record of the following section passed through in the yard of the Glazed Faience Co., a little S.E. of Selby Station :—

	Ft.	In.
Surface soil	1	6
Running sand	3	6
Alluvial clay	24	6
Greenish running sand, with some water	2	0
Brown clay, getting red	9	1

MARINE AND OTHER FOSSILS IN THE YORKSHIRE COAL MEASURES ABOVE THE BARNSLEY SEAM, AS SEEN AT THE BENTLEY COLLIERY, NEAR DONCASTER.

BY H. CULPIN.

(*Read 4th November,* 1909. *Manuscript received 2nd December,* 1909.)

During the sinking operations to the Barnsley seam at the Bentley Colliery, near Doncaster, the opportunity was taken of examining the material brought to the surface, with the result that the accompanying section (p. 77) and lists of fossils (pp. 78-81) can now be put on record. These particulars, it is suggested, will be found useful, in conjunction with those from Brodsworth (Proc. Yorks. Geol. Soc., 1908, pp. 321-333), in their bearing on the exploration of the concealed coalfield east of Doncaster. They have already proved very helpful in locating position.

The situation of the Bentley Colliery is 2½ miles north of Doncaster and 2½ miles east of Brodsworth Colliery. The Barnsley Coal was 9 feet 5 inches thick at Brodsworth, and was reached at a depth of 1,645 feet below Ordnance Datum. At Bentley it was 9 feet 8 inches thick, its depth below Ordnance Datum being 1,842 feet. The description of the seam at Bentley is as follows :—

	ft.	in.
Soft Coal	4	1
Parting	0	4½
Hard Coal ...	2	9
Soft Coal	2	5½
	9	8

The marine shells at Bentley, which numbered 38 species, were found in four bands, the comparison with Brodsworth (21 species), in regard to positions, being as under :—

	Marine Bands, height in feet above Barnsley Coal. Bentley.	Brodsworth.
M.B. above Shafton Coal ...	1,131 ...	1,157
M.B. with Limestone Base ...	675½ ...	705
M.B. (*Lingula*)	589 ...	Not seen.
M.B. above Cannel Coal ...	393 ...	382
M.B. (*Lingula*)	Not seen ...	111

Of the freshwater shells, *Anthracomya Phillipsi* was found in abundance at one level near the top of the Coal Measures, and sparsely some 100 feet above the Barnsley Coal. The experience, so far, in sinkings and borings in the Doncaster district, is that its occurrence in large numbers is confined to the higher beds of the Coal Measures. What may prove to be a new species of *Anthracomya* has been obtained by Mr. H. T. Foster from the roof of the Duncil seam, about 50 feet below the Barnsley Coal. It appears to be a descendant of *A. Adamsi*.

There was a prolific bed of plant remains about 125 feet above the Shafton Coal, and as the list shows, plants were numerous at several positions in the beds from 320 feet above the Barnsley seam until the coal itself was reached.

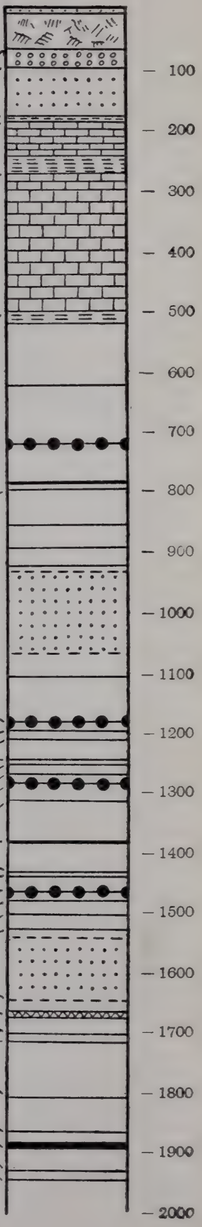
Fish fragments were found at various depths, but mainly in or near the marine bands. *Listracanthus Wardi* was obtained by Dr. Walcot Gibson from the principal marine band, which is the one with the limestone base, about 700 feet above the Barnsley Coal.

Thanks are due, and are hereby given, to Dr. Wheelton Hind, Dr. Edgar D. Wellburn, and Dr. R. Kidston for examining and naming the fossils. Also to Mr. R. Clive and Mr. H. T. Foster, of the Bentley Colliery, for facilities and assistance given in the examination of the material tipped and its verification in the shafts.

SECTION OF SINKING AT BENTLEY, 2½ MILES NORTH OF DONCASTER, YORKSHIRE.

SURFACE OF GROUND 21 FT. ABOVE ORDNANCE DATUM.

		Thickness. Ft.	Thickness. In.	Depth from Surface. Ft.	Depth from Surface. In.
	Soil		9		9
	Alluvium	78	3	...	
	Boulder Clay	21	0	79	0
				100	0
	TRIAS (Bunter Sands and Marls)	80	6	...	
PERMIAN	Upper Marls	4	4	180	6
				184	10
	Upper Limestone	53	2	...	
				238	0
	Middle Marls	34	0	...	
				272	0
	Lower Limestone	233	6	...	
	Lower Marls	15	10	505	6
	Coal Measures entered at	...		521	4
	Coal		5	620	8
	MARINE BAND in Blue Bind	21	0	711 732	0 0
	SHAFTON COAL	4	0½	782	1½
	Coal		10	788	10
	Coal	1	4	852	2
	Coal		1½	889	2½
	Coal	1	1	919	3
	Sandstone and Sandy Shale	121	11	..	
				1057	6
	Coal	1	6	1102	1
	MARINE BAND	16	6	1187	6
	Coal with Black Batt		5	1187	11
	Coal		8	1202	8
	Coal		7	1239	7
	Coal	1	1	1240	11
	Coal		4	1263	9
	MARINE BAND	...		1274	0
	Coal	2	0	1313	4
	MELTON FIELD (WATH WOOD) COAL	3	4	1374	5
	Coal (including 2½ inches Batt) } Two Foot Coal	1	9	1429	2
	Coal	1	4	1432	5
	MARINE BAND	6	1	1470	9
	ABDY COAL (Cannel)	3	8	1474	5
	BEAMSHAW COAL	2	3	1498	5
	Coal		9	1527	1
	Sandstone and Sandy Shale	113	6	...	
				1646	11
	Blue Bind with "Cone-in-cone" Structure	...		1656	5
	KENT'S THICK COAL	2 1	3 1	1692 1715	7 0
	BARNSLEY RIDER COAL		5	1805	8
	Coal	1	6	1859	6
	BARNSLEY COAL	9	8	1872	8½
	Dunsil Coal	5	1	1925	7
	Coal		1½	1926	11½



LIST OF FOSSIL FISH REMAINS FROM BENTLEY COLLIERY, 2½ MILES NORTH OF DONCASTER, YORKSHIRE.

PISCES.	Depth from surface. Ft.	521	732	782	885½	1171 1187½	1274	1330	1374½	1425	1470	1863 to 1872½
	Height above Barnsley Coal. Ft.	1342	1131	1081	977½	692 675½	589	533	488½	438	393	
ELASMOBRANCHII.		BASE OF THE PERMIAN.		BASE OF THE SHAFTON COAL (4 FT. 0½ IN.).					BASE OF THE MELTON FIELD (WATH WOOD) COAL (3 FT. 4 IN.).			BARNSLEY COAL (9 FT. 8 IN.).
Acanthodes major, Davis			...		...	*	...	...		...	...	
,, *Wardi*, Egert.			*		...	*	*	*		...	*	
Listracanthus Wardi, A. S. Woodw.			...		...	*	...	...		...	...	
Pleuracanthus sp.			...		...	...	...	*		...	...	
TELEOSTOMI.			(MARINE BAND).			(MARINE BAND).	(MARINE BAND).				(MARINE BAND).	
Cœlacanthus elegans, Newb.			*		*	*	...	...		...	*	
,, sp.			*		...	*	...	*		...	*	
Elonichthys Egertoni, Agass.			*		...	...	...	...		...	...	
,, sp.			...		...	*	...	...		...	...	
Megalichthys Hibberti, Agass.			*		...	*	...	...		...	*	
Platysomus parvulus, Agass.			*		...	*	...	...		...	*	
,, sp.			*		...	...	...	...		...	...	
Rhadinichthys monensis, Egert.			*		...	...	...	...		...	*	
Rhizodopsis sauroides, Williamson			...		...	*	...	...		*	...	

Depth from surface. Ft.	521	530	550	654	689	732	782	1187½	1274	1374½	1470	1481	1489	1545	1560	1656	1706	1764	1805	1835	1850	1863 to 1872½	1950
Height above Barnsley Coal. Ft.	1342	1333	1313	1209	1174	1131	1081	675½	589	488½	393	382	374	318	303	207	157	99	58	28	13		77½
Ferns and Fern-like Plants.																							
Sphenopteris obtusiloba, Brongt.	Base of the Permian.	...	...	*	...	...	Base of the Shafton Coal (4 Ft. 0½ In.).	Base of Marine Band (16½ Ft.).	Marine Band.	Base of the Melton Field (Wath Wood) Coal (3 Ft. 4 In.).	...	...	...	*	*	...	*	...	...	...	...	Barnsley Coal (9 Ft. 8 In.).	...
,, *dilatata*, L. & H.		...	...	...	...	Marine Band.					...	...	...	*	...	...	...	...	...	...	...		...
,, cf. *Jacquota*, Zeiller sp.		...	...	...	...						...	...	...	*	...	...	...	...	...	...	...		...
,, *artemisiæ folioides*, Crépin.		...	...	...	...						...	...	...	...	*	...	...	...	...	...	...		...
,, cf. (*Diplothmema*) *Crépini*, Stur.		...	...	...	...						...	...	...	*	*	...	...	...	...	...	...		...
,, sp.		...	...	...	...						...	...	...	*	...	...	...	...	...	...	...		...
Crossotheca schatzlarensis, Stur. sp.		...	...	*	...						...	...	...	...	...	...	...	...	...	...	...		...
cf. *Eremopteris artemisiæ folia*, Sternb. sp.		...	...	...	...						...	...	...	...	...	...	...	...	...	...	*		...
Urnatopteris tenella, Brongt. sp.		...	...	...	...						...	...	*	...	...	...	...	...	...	...	...		...
Mariopteris muricata, Schl. sp.		...	...	*	...						...	...	...	*	...	...	...	...	...	...	...		...
Alethopteris lonchitica, Schl. sp.		...	...	*	...	...					...	...	...	...	*	...	...	...	...	*	*		...
Neuropteris heterophylla, Brongt.		...	...	*	...	*					Marine Band.	...	...	...	...	...	*	...	...	*	*		...
,, *tenuifolia*, Schl. sp.		...	...	...	...	...						...	*	*	*	...	...	...	...	...	...		...
,, *gigantea*, Sternb.		...	...	*	...	...						...	...	...	...	...	*	...	...	*	*		...
,, *obliqua*, Brongt. sp.		...	...	*	...	...						...	...	...	...	...	...	...	...	...	...		...
,, *impar*, Weiss. sp.		...	...	*	...	...						...	...	...	...	...	...	...	...	...	...		...
,, *Scheuchzeri*, Hoffm.		*	...	...	...	...						...	...	*	...	...	...	...	...	...	...		...
,, sp.		*	*	...	...	...						*	...	...	...	...	...	...	...	...	...		...
Cyclopteris sp.		...	...	*	...	...						...	...	...	...	...	*	...	...	...	...		...
Equisetales.																							
Calamites ramosus, Artis.		...	...	...	...	...					...	...	...	...	...	...	...	...	...	...	*		...
,, sp.		*	*	...	...	...					...	...	...	...	...	...	...	...	...	...	...		...
Annularia radiata, Brongt.		...	...	...	...	...					...	...	...	...	...	...	...	...	...	...	*		...
Asterophyllites equisetiformis, Schl. sp.		...	...	...	...	...					...	...	...	*	*	...	...	...	...	...	...		...
Lycopodiales.																							
Lepidodendron ophiurus, Brongt.		...	...	...	...	...					...	...	...	...	...	...	*	...	...	...	...		...
,, *obovatum*, Sternb.		...	...	*	...	...					...	...	...	...	...	...	...	*	...	...	...		...
,, *similis*, Kidston		...	...	...	...	...					...	...	...	...	...	*	...	...	...	...	...		...
(= *Lepid. lycopodioides*, Zeiller *non* Sternb.)																							
,, *Wortheni*, Lesqx.		...	...	...	...	...					...	...	...	...	...	...	...	...	*	...	...		...
,, sp.		...	...	...	*	*					*	...	...	...	...	...	...	...	...	...	...		*
Bothrodendron minutifolium, Boulay sp.		...	...	...	...	...					...	...	...	*	...	...	...	...	...	...	...		...
Sphenophyllales.																							
Sphenophyllum trichomatosum, Stur.		...	...	*	...	...					...	...	...	...	...	...	...	...	...	...	...		...
Cordaitales.																							
Cordaites sp.		...	...	*	...	...					...	...	...	...	...	...	...	...	...	...	...		...
Dorycordaites palmæformis, Göpp. sp.		...	...	...	...	...					...	...	...	...	...	...	*	...	...	...	...		...
Rootlets of Unknown Attribution.																							
Pinnularia columnaris, Artis. sp.		...	...	*	...	...					...	...	...	*	...	...	*	...	...	...	...		...

LIST OF FOSSIL SHELLS, &C., FROM BENTLEY COLLIERY, 2½ MILES NORTH OF DONCASTER, YORKSHIRE.

		521	666	689	732	782	885	1068	1100	1187½	1236	1274	1330	1350	1356	1374½	1425	1470	1476	1481	1641	1650	1656	1689	1758	1805	1835	1863 to 1872½	1920	1950
	Depth from surface. Ft.	521	666	689	732	782	885	1068	1100	1187½	1236	1274	1330	1350	1356	1374½	1425	1470	1476	1481	1641	1650	1656	1689	1758	1805	1835	1863 to 1872½	1920	1950
	Height above Barnsley Coal. Ft.	1342	1197	1174	1131	1081	978	795	763	675½	627	589	533	513	507	488½	438	393	387	382	222	213	207	174	105	58	28		47½	77½
	CRINOIDEA.																													
	Crinoid stems		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	CRUSTACEA.																													
	Ceratioceras		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...					
	BRACHIOPODA.																													
	Chonetes laquessiana mut. θ. de Kon.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Lingula mytiloides, Sow.		...	...	*		...	...	...	*	...	*	...	...	...		...	*	...	...	...	...								
	Orbiculoidea nitida, Phill.		...	...	...		...	...	...	...	...	*	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Productus small		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...						
	,, spines		...	...	...		...	...	...	...	...	*	...	...	...		...	...	...	...	...									
	Rhipidomella cf. *Michelini*, Léveillé		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	LAMELLIBRANCHIATA.																													
FRESHWATER.	*Anthracomya Phillipsi*, Will.	BASE OF THE PERMIAN.	*	...	...	BASE OF THE SHAFTON COAL (4 FT. 0½ IN.).	...	...	...	(MARINE BAND 1171 ft. to 1187½ ft.).	...	...	...	...	...	BASE OF THE MELTON FIELD (WATH WOOD) COAL (3 FT. 4 IN.).	...	...	...	...	...	...	...	?	*	...		BARNSLEY COAL (9 FT. 8 IN.).		
	,, (?) *Wardi*, Eth.		...	...	...		...	...	...		...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	*
	,, sp.		...	...	...		...	...	...		...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	
	Carbonicola acuta, Sow.		...	...	...		...	...	...		...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		*	
	,, var. *acuta*, Sow.		...	...	...		...	...	...		...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	*		...	
	,, *aquilina*, Sow.		...	...	...		...	...	...		...	...	*	*	*		...	...	*	*	*	*	*	*	...	...	...		*	
	,, cf. *nucularis*, Hind		...	...	...		...	...	...		...	...	...	...	...		...	...	...	...	*	...	...	...	...	...	...		...	
	,, cf. *obtusa*, Hind		...	...	...		...	...	...		...	...	...	...	...		...	...	...	*	...	...	...	...	...	...	...			
	,, sp.		...	...	...		...	...	...		*	...	...	...	...		*	...	...	...	...	...	...	...	*	...	...		...	*
	Naiadites modiolaris, Sow.		*	*	...		*	*	*		*	*	*	...	...		*	...	...	...	*	...	*	...	*	*	...		...	*
	,, *triangularis*, Sow.		...	...	...		...	...	...		...	...	...	...	...		...	...	...	...	...	...	*	...	...	...	...		...	.
MARINE.	*Aviculopecten Culpini*, Hind		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Ctenodonta lævirostrum, Portl.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Edmondia sp.		...	...	...		...	...	...	*	...	...	...	...	...		...	*	...	...	...	...	...	...	...	...	...			
	Myalina compressa, Hind		...	...	...		...	...	...	...	...	*	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Nucula æqualis, Sow.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	,, cf. *gibbosa*, Flem		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Posidoniella lævis, Brown		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	
	,, *sulcata*, Hind		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	Pseudamusium fibrillosum, Salter		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	.
	Pterinopecten carbonarius, Hind		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	,, *papyraceus*, Goldf.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Sanguinolites sp. nov.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	Scaldia carbonaria, Hind		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	,, *minuta*, Hind		...	...	...		...	...	...	...	...	...	...	...	...		...	*	...	...	...	...	...	...	...	...	...			
	,, sp. (large)		...	...	...		...	...	...	...	...	...	...	...	...		...	*	...	...	...	...	...	...	...	...	...			
	Solenomya primæva, Phill.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Syncyclonema carboniferum, Hind		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	.
	GASTEROPODA.																													
	Euphemus cf. *Urei*, Flem.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...				
	,, sp.		...	...	...		...	...	...	...	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...				
	Loxonema acuta, de Kon.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...				
	Raphistoma radians, de Kon.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	CEPHALOPODA.																													
	Cœlonautilus		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Dimorphoceras Gilbertsoni, Phill.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Gastrioceras carbonarium, L. von Buch.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	Glyphioceras cf. *micronotum*, Phill.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...			
	,, sp.		...	...	*		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	Orthoceras asciculare, Brown		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	,, cf. *asciculare*, Brown		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	,, *Koninckianum*		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	,, (?) *scalare*, Goldf.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	,, sp.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		...	...
	Pleuronautilus costatus		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		.	
	,, cf. *pulcher*, Crick		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		.	
	Solenocheilus sp.		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		..	
	Temnocheilus carbonarius, Foord		...	...	...		...	...	...	*	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...		..	

MARINE BANDS IN THE MILLSTONE GRIT OF WHARFEDALE.

BY G. V. WILSON, B.Sc.

(*Read 4th March,* 1909. *Manuscript received 8th November,* 1909.)

About one mile to the north of Otley there is situated, on the sides of Clifton Beck, a large exposure which shows the following succession, dipping at an angle of 12° to the south-east :—

Top not seen.

ft.	in.	
50–60	0	... ... Hard black shale.
	4	... ... Black micaceous sandy shale.
1	0	... ... Yellow micaceous sandy shale.
		Weston Grit.

Base not seen.

At the base is the Weston Grit, which is seen in the bed of the stream, and this passes up into a soft, very micaceous, yellow shale, containing *Glyphioceras bilingue*, which is succeeded by a thin band of black micaceous shale, with *Posidoniella lævis*. Overlying this bed is the main mass of black carbonaceous shale with very little mica, which is very hard at the base, but towards the top becomes softer and more ferruginous, weathering into boxstones.

In the lower part are several small layers of crystalline limestone with crinoid stems, but none of these layers is more than a quarter of an inch in thickness. There are also numerous small nodules, both of iron-pyrites and earthy limestone, without fossils. From the shale itself the following fossils have been obtained :—

ECHINODERMATA.

Crinoid stems.

LAMELLIBRANCHIATA.

Chœnocardiola Footii.
Aviculopecten carboniferus.
Pterinopecten papyraceus.
Pseudamusium fibrillosum.
Posidoniella lœvis.
Posidoniella Kirkmani.

CEPHALOPODA.

Glyphioceras bilingue.
Glyphioceras micronotum.
Orthoceras (*striatulum*) ?
Orthoceras Morrisianum.

Another locality where I have found marine bands is near Fewston. Here a tunnel has lately been driven from Kettlesing Bottom to Swinsty Reservoir for the purpose of bringing the Colsterdale water to Swinsty, whence it is conducted to Leeds.

The tunnel is about three miles long and passes through rocks of Millstone Grit age for the whole of the distance, the general structure of the country being that of a broad anticline whose axis is at right angles to the direction of the tunnel.

The tunnelling has been carried out from both ends and also from a series of intermediate shafts. From the spoil heaps at these places I have obtained a large number of fossils.

Number 1 *Shaft*, at the south end of the tunnel.—Here the material exposed was a dark blue shale, which rapidly weathered to a friable mass, and contained a large number of Clay Ironstone nodules, which often enclosed fossils.

From the general mass of the shale I obtained the following fossils :—

BRACHIOPODA.

Lingula mytiloides.

LAMELLIBRANCHIATA.

Posidoniella lœvis.
Myalina peralata.
Pseudamusium fibrillosum.

CEPHALOPODA.

Glyphioceras micronotum.
Orthoceras sp.

PISCES.

Elonichthys Aitkini.
Elonichthys sp.

CRUSTACEA. Not yet identified.

Number 2 *Shaft.*—Here there is only a small spoil heap, owing to the shaft having filled with water and been abandoned. The material is a very fissile black shale, often very fossiliferous and containing numerous nodules, rich in well preserved fossils. One nodule contained some vegetable tissue of which I made microscopic sections, which show the internal structure exceedingly well.

From here I have obtained—

CEPHALOPODA.

Glyphioceras micronotum.
Orthoceras } Fragments of large specimens too poor
Goniatites } to identify.

PLANTÆ.

Medullosa anglica.

Number 3 *Shaft.*—From here the tunnel was driven both ways, and the material brought from the northern face was a micaceous shale of a fluviatile type, in which I found no marine fossils.

The material from the southern face was a hard blue shale often containing small nodules of pyrites in definite bands.

Here I obtained the following :—

BRACHIOPODA.

Lingula mytiloides.
Productus (spines).
Rhynchonella (sp.).

LAMELLIBRANCHIATA.

Nucula æqualis.
Ctenodonta lævirostris.
Nuculana lævistriata.
Grammatodon sp.

GASTEROPODA.

Euphemus Urei.
Naticopsis brevispira.
Loxonema sp.
Ptychomphalus sp.
Belerophon sp.

CEPHALOPODA.

Cœlonautilus quadratus.
Solenocheilus cyclostomus.
Actinoceras sp.

As to the horizon at which these beds occur, all I can say at present is that they are above the Otley Shales, which are probably a portion of the Sabden Shales, and that they are below the Cayton Gill Beds.

My thanks are due to Dr. Wheelton Hind, Mr. Edgar D. Wellburn, and the Leeds University Botanical Staff for examining and naming the invertebrata, the fish remains, and the plant. Also to Professor Kendall for suggestions and assistance, and to Mr. Richard Chamberlain, the Resident Engineer, for permission to examine the material and for information as to dips.

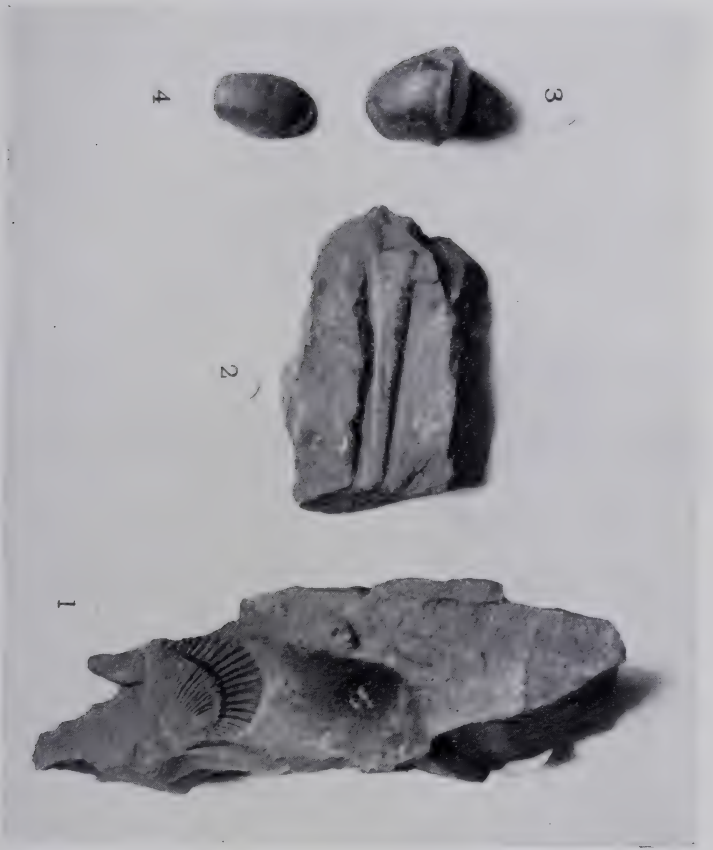


Fig. 1.—AVICULOPECTEN CARBONIFERUS.
Fig. 2.—ORTHOCERAS (STRIATULUM ?)
Figs. 3 and 4.—SOLENOCHEILUS CYCLOSTOMUS.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate II.

ON AN APPARATUS FOR DETERMINING THE INCLINATION AND DIRECTION OF BORE HOLES AND THE DIP AND DIRECTION OF THE DIP OF STRATA PASSED THROUGH BY BORE HOLES.

BY JOHN GOODMAN, PROFESSOR OF ENGINEERING
IN THE UNIVERSITY OF LEEDS.

(*Read* 4*th March*, 1909. *Manuscript received* 30*th December*, 1909.)

The apparatus is for the purpose of determining the inclination and the direction of the inclination of bore holes, which when carried to a great depth are liable to run away from the vertical direction. It furnishes also means whereby the dip or inclination of the strata passed through by the bore holes and the direction of the same can be ascertained.

The apparatus consists of a hollow pendulum, in the form of a hollow cone of any light and suitable material, preferably non-magnetic. Aluminium is well suited for the purpose. The full angle of the pendulum cone is about 100 degrees.

A pivot pin secured to a circular base plate supports the pendulum from the apex end of the hollow of the pendulum in such manner that the base plate and pivot pin can be tilted at a considerable angle and still allow the pendulum to hang truly vertical. An agate bearing is inserted in the apex of the hollow of the pendulum or cone. A magnet is secured to the upper end or apex of the pendulum by a screw projecting from the apex of the same and passing through a hole in the centre of the magnet, and a nut or cap screwing on to the same. The nut is formed with a hemispherical cap, the centre of which, when the nut is screwed down on to the magnet, coincides with the point of support for the cone, that is the point of the pivot.

The above-mentioned base plate is connected by two or more pillars to a second circular base plate—the clockwork base plate.

A spindle is provided passing through a central hole in the clockwork base plate in the same vertical line as the pivot, and carries a plunger or enlargement at its lower end, the underside of which is hollow, so that when pressed against the upper side of the hemispherical cap, it bears with its circular rim against the same ; the contact of the rim and hemispherical cap taking place at the same instant all round the rim of the plunger, and not at one part before the other.

A helical or other spring surrounding the spindle bears with its lower end against the upper side of the presser or enlarged head of the plunger, and with its upper end against the underside of the clockwork base plate.

The end of the plunger projecting above the clockwork base plate is connected with a trigger or other release device, operated by clockwork mounted on the clockwork base plate. When the plunger is raised by pulling up the presser spindle and compressing the spring, the cone is released so as to swing freely on its pivot support, and the spindle is held raised by a catch device or a wound-up cord or chain. The clockwork is set for a given time of release and set going, so that when the time elapses the catch is released, allowing the plunger to be pushed down by the spring. In the case of a wire wound on a barrel, the clockwork device may be arranged to allow the plunger to move slowly downwards as the wire gradually unwinds from the barrel, coming in contact with the hemispherical cap after the lapse of a given time interval.

The apparatus is fitted and carried in a hermetically closed tube, attached to a rope or rods for being lowered into the bore hole.

The apparatus is lowered into the bore hole with the pendulum swinging freely on its support, and the magnet free to swing into the magnetic meridian, turning the pendulum with it, and with the clockwork release apparatus set to allow ample time for the apparatus to be lowered, and for the pendulum and magnet to come to rest. It will be evident that under these conditions the angle of inclination to the vertical of the bore hole will be the same as the angle between the plane of the base of the cone pendulum and the base plate below it ; whilst the angle between the direction or line of greatest inclination of the base of the cone pendulum to the base plate, and the direction of the magnet will give the horizontal direction of the deviation of the bore hole from the vertical.

The release device of the clockwork fixes the magnet and cone in these positions with respect to the apparatus and to each other.

To facilitate reading the last-mentioned angle, the rim of the cone close to the base is marked with degrees all round.

The angle of inclination of the cone is most conveniently obtained by measuring off by means of a gauge or cathetometer the highest and lowest points of the base rim of the cone from the base plate.

In order to apply the apparatus for the purpose of ascertaining the dip and direction of the dip of the strata, the tube enclosing the apparatus is prolonged downwards and provided on the inside with one or more cutting or scratching teeth. When the lower end of the tube is dropped down over and raised again from the unbroken end of the core in the bottom of the bore hole, a scratch or scratches are left on the outside of this core, so that when the latter is afterwards broken off and raised, its position with respect to the apparatus and consequently to the readings obtained from the apparatus as previously described can be determined, and hence the dip and direction of the dip of the strata as shown by the core.

A modification of the method of using the apparatus for this latter purpose is to bore a hole into the core to receive the apparatus, and fix it in the core by dropping cement into the hole above the apparatus. After the cement has set, the core is broken off and raised to the surface with the apparatus inside.

In order that the apparatus may be more readily and clearly understood, a drawing is annexed (Fig. 1), which is a section of the inclined part of a bore hole containing the apparatus, the latter being shown partly in section :—*a* indicates the sides of the bore hole, and *b* the hollow cylinder enclosing the apparatus ; *c* is the hollow pendulum cone supported by the pivot pin *d*, carried by the base plate *e* ; *i* is an agate inserted in the apex of the hollow of the cone, to reduce liability to derangement from wear between the point of the pivot pin and the part of the cone resting immediately on the point. The upper end of the cone terminates in a short screwed stem *g*, and a magnet *h* rests on the shoulder at the bottom of the stem ; *k* is a cap nut, which is screwed down on to the stem *g* and secures the needle *h* to the top of the cone *c*. The cap portion of the nut *k* is formed on the outside as a hemisphere, having the point of the pivot pin *d* as its centre.

The base plate *e* rests on a ledge or flange formed on the inside of the enclosing cylinder *b* ; *l* is the so-called clockwork base plate, which is carried from the base plate *e* by two more pillars *m*.

Immediately above the cap nut *k* and in the central or axial line of the apparatus is provided a spindle or plunger *n*, which passes through and is guided by a hole in the boss on the underside of the clockwork base plate. The lower end n^1 of the spindle or plunger is enlarged and made hollow, so that when pressed against the hemispherical cap, it bears only with its circular rim against the cap ; *o* is a helical spring surrounding the spindle or plunger *n*, resting with its lower end on the enlargement n^1 and bearing with its upper end against the underside of the clockwork base plate *l*. The upper part of the plunger or spindle *n* passes through a hole in the lever *p*, the latter being hinged at *q*. A cross pin *r* is fitted in the spindle immediately above the lever *p*, so that when the latter is raised the plunger *n* is lifted out of contact with the cap nut *k*, allowing the pendulum cone *c* to swing free with its base truly horizontal. When the lever *p* is released, the helical spring *o* pushes the plunger down on to the nut cap, fixing the cone and needle in the position which they have at the time with respect to the apparatus ; *s*, as shown, is a case containing an ordinary alarum clock, which is carried on the clockwork base plate. The free end of the lever *p* is connected to the lower end of a flexible wire or cord *t*, the upper end of which is secured to the projecting end *u* of the alarum spindle, so as to be wrapped round the same when the alarum is wound up, thus raising the lever *p*, lifting the plunger *n* and allowing the cone and magnet to hang free. The alarum release is then set to go off after a certain time interval, and in this state the apparatus is lowered into the bore hole. On the lapse of said interval, the alarum release goes off and the spindle *u* runs down, unwinding the cord *t* and freeing the spring *o* to push down the plunger *n*, which latter fixes the cone and the magnet in the position in which they have come to rest.

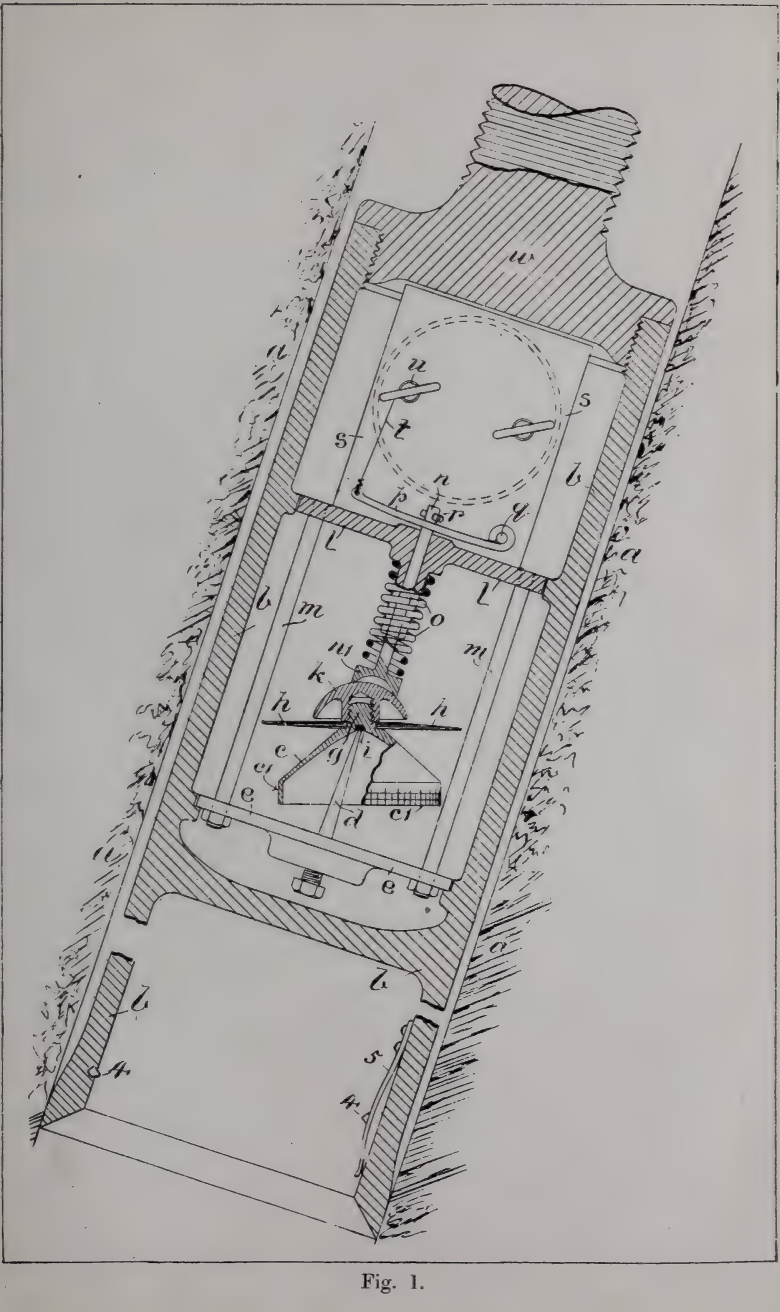


Fig. 1.

The upper end of the hollow cylinder *b* is hermetically closed by the cover or cap piece *w*.

The means above set forth for freeing the magnet and cone and for securing them in any position in which they may have come to rest are not limited, as other means both mechanical and electrical suitable for effecting this purpose are well known or will readily suggest themselves.

The rim c^1 of the cone is graduated all round in degrees as shown on the righthand side of the cone, the magnet being secured so that its centre line lies in the central plane of the cone passing through the zero and 180° mark. The angle of inclination of the cone is most readily ascertained by finding by means of a gauge or cathetometer the highest and lowest points respectively of the base rim of the cone from the base plate *e*. The difference between these heights divided by the diameter of the base of the cone will give the sine of the angle of deviation of the bore hole from the vertical. 4 are scratchers or scrapers of steel, diamonds, or the like, secured on the inner side of the tube *b* close to the lower end of the same, so that by raising and lowering the bottom of the tube in the annular space surrounding the core, scratches or marks can be made on the sides of the cone, so that when this portion of the core is afterwards broken off and brought to the surface, if the lines of bedding can be traced, the dip and direction of the dip of the strata, as shown by the core, can be deduced. To facilitate the marking of the core, the scratchers may be formed on or attached to a flat spring or springs 5, secured to the lower end of the tube.

REPORT OF THE HON. SECRETARIES, 1909.

The year has been one of quiet progress. There has been a very satisfactory increase in the membership, which now stands at 223. By the death of the Marquis of Ripon, K.G., who presided over the Society for 50 years, we have been deprived of a President who always took a true interest in our welfare and work. Whenever it was possible he presided at the Annual General Meeting, and in many ways used his high influence for the promotion of our best interests. A resolution of deep regret and sympathy was passed by the Council, and the Society was represented at the Memorial Service and funeral at Ripon by Messrs. W. Lower Carter and J. T. Simpson. We also regret the loss by death of Sir S. W. Duncan, Bart., for 22 years a member of our Society ; of Mr. Wilfred H. Hudleston, F.R.S., a distinguished geologist, and ex-President of the Geological Society of London, who was a member of our Society for 27 years ; and of Mr. J. T. Atkinson, F.G.S., of Selby, a member for 34 years and a Vice-President of the Society.

During the year 16 new members have been admitted, and 8 have withdrawn from the Society, leaving a net gain of 4 over last year's total.

The General Meetings and Field Excursions have been well attended and successful. The Spring General Meeting was held as usual in Leeds on March 4th under the presidency of Mr. Godfrey Bingley. A paper was read by Mr. G. V. Wilson on "Marine Bands in the Millstone Grit Series of Wharfedale." Mr. Albert Gilligan, B.Sc., followed with "A Note on some Pebbles from the Millstone Grit at Silsden," and Mr. Edwin Hawkesworth contributed "A Note on a Boring at East Harlsey." In the absence of Professor Goodman, Dr. A. R. Dwerryhouse described an apparatus for determining the Inclination of Bore Holes, which had kindly been exhibited by the former gentleman. A Field Excursion had been taken earlier in the day to Newlay to view some interesting gravels, and a brief description by the leader, Mr. S. Margerison, concluded the programme.

The Easter Meeting and Field Excursion were held at Kirkby Lonsdale under the presidency of Mr. Wm. Robinson, of Sedbergh. On Friday, April 9th, the Lower Carboniferous at Brigsteer was visited, and junctions with the underlying

Silurian without any intervening red conglomerate were noted. On Saturday the red conglomerate at Castleton was examined, and the sections along Barbon and Barkin Becks were followed as far as Short Gill. The Coniston Limestone near Peas Gill House was also examined.

At the General Meeting a resolution of congratulation was passed to Professor P. F. Kendall on the award of the Lyell Medal by the Geological Society of London, and also to Mr. H. Brantwood Maufe who was, in conjunction with Mr. R. G. Carruthers, awarded the balance of that fund. An invitation was received from the Lord Mayor of Leeds to the Public Health Congress at Leeds, and Mr. Wm. Simpson was appointed our delegate.

Mr. William Robinson (Chairman) delivered an address in which he referred to the important sections of the Red Beds in the Kirkby Lonsdale and Sedbergh districts. Mr. Cosmo Johns then introduced a discussion on the red conglomerates and their equivalents in other areas, with special reference to their age. After an interesting discussion, Mr. R. G. Carruthers, of H.M Geological Survey, gave an account of the development of *Zaphrentis delanouei*, a small coral which is found in several limestones in the Lower Carboniferous of Scotland, and shows modifications from a wide fossula to a parallel fossula; then the fossula becomes restricted at the inner end, and finally the septa are merely disjuncted.

The Summer Excursion was taken to Hayburn Wyke, but the weather did not prove very favourable. On June 24th the party assembled, and on June 25th the section from Peak to Hayburn Wyke was examined. The General Meeting was held the same evening under the presidency of Mr. G. W. Lamplugh, F.R.S. (in the absence through illness of Mr. Thomas Sheppard, F.G.S.). The Chairman and Mr. J. W. Stather described the local geology, and a conversation followed. A vote of sincere regret at Mr. Sheppard's absence was unanimously adopted. On June 26th the party went by the shore from Cloughton to Hayburn Wyke, examining the excellent sections in the Estuarine Beds with their limestone bands. On June 28th a smaller party drove to Hackness and by way of Forge Valley to Ayton, many fossiliferous sections being visited.

In September the last General Meeting for the season was held at Gainsborough under the presidency of Mr. F. M. Burton, F.G.S. On September 24th the train was taken to Frodingham where the party was met by local geologists. The day was spent in examining the Frodingham Ironstone and the interesting superficial deposits in the many sections now available as a result of the great extension of the ironstone workings. At the General Meeting a short account of the geology of Gainsborough and neighbourhood was given by the Chairman, and Mr. H. Preston read a paper on "The Rhætic Deposits of the District." A very interesting discussion followed. On September 25th a visit was paid to the escarpment overlooking the Trent Valley and the famous section of the Rhætic Beds at Lea. On September 26th the party visited Kirmington, where the inter-glacial deposits were examined.

Early in the year the Geological Society of Glasgow celebrated their jubilee, and Mr. H. Brantwood Maufe attended as the representative of our Society.

For the British Association Meeting at Winnipeg three members of our Society were appointed officers of Section C—Dr. A. Smith Woodward, F.R.S. (President), Mr. W. Lower Carter (Recorder), and Dr. A. R. Dwerryhouse (Secretary).

The important office of President of our Society having become vacant by the death of Lord Ripon, the Council carefully considered the policy to be adopted, and passed the following recommendation :—"That in the opinion of the Council in the future the President should be selected from among the members of the Society taking an active interest in its work, or not being a member should be a geologist of distinction connected by birth or his researches with Yorkshire. Further, ordinarily, that election to the office should be for one year, but that the President might be re-elected for a second year."

The following places for General Meetings and Field Excursions in 1910 were recommended :—

Spring Meeting—Leeds.
Easter—Coxwold or Gilling District.
June or July—Belgium or the Criffel.
September—Sunderland for the Permian Rocks.
November—Leeds (Annual Meeting).

THE YORKSHIRE GEOLOGICAL SOCIETY.

Statement of Receipts and Expenditure, from October 31st, 1908, to October 31st, 1909.

REVENUE ACCOUNT.

Dr.

1908.	**Receipts.**	£	s.	d.	£	s.	d.
Nov. 1	To Balance from last account				29	2	8
	,, One Life Member's Subscription ...				6	6	0
	,, Members' Annual Subscriptions and Arrears				87	15	0
	,, Sales of Proceedings						
	,, Received for Authors' Reprints	0	9	0			
		0	18	0			
		9	11	6			
		0	7	6			
		0	4	3			
					11	10	3
	,, Interest on Mortgage Bonds of Halifax Corporation				12	3	10
	,, Income Tax Recovered				1	10	11
	,, Owing to Chorley & Pickersgill	15	0	4			
	,, Less Cash in Hand and in Bank	2	12	9			
	Debtor to Cash on Year	12	7	7	12	7	7
					£160	16	3

Cr.

1909.	**Expenditure.**	£	s.	d.	£	s.	d.
Nov. 1	By Amount put to Investment with the Halifax Corporation				10	0	0
	,, MEETINGS, EXCURSIONS, AND SECRETARIES' POSTAGES				11	1	7
	,, CHORLEY & PICKERSGILL'S ACCOUNTS—						
	Proceedings	90	8	11			
	Reprints	17	1	10			
	Meetings and Circulars ...	13	4	11			
	Postages paid	8	1	6			
	Stationery for Secretaries	2	6	6			
		131	3	8			
	,, Cash paid on account of above				116	3	4
	,, Balance owing				15	0	4
	,, STATIONERY PER TREASURER—						
	Whitley & Booth	0	13	9			
	Stott Brothers	0	4	6			
	Sundry Postages	1	5	9			
					2	4	0
	,, A. H. Searle's Account				0	15	0
	,, "Griffin" Year Book...				0	6	0
	,, Stanford Maps..				5	3	0
					£160	16	3

CAPITAL ACCOUNT.

1909.		£	s.	d.
Oct. 31	To Halifax Corporation Mortgage Bonds	370	0	0
	,, One Life Member's Subscription	6	6	0
	,, Books, Proceedings, Maps, &c., at the Leeds University, as per Agreement dated 20th November, 1907, in the custody of the Halifax Joint Stock Banking Co. ...			
		£376	6	0

1909.		£	s.	d.
Oct. 31	By Transfer to Revenue A/c	6	6	0
	,, Halifax Corporation Mortgage Bonds	370	0	0
		£376	6	0

Leeds, November 3rd, 1909.

Examined and found correct, F. W. BRANSON, *Hon. Auditor.*

WILLIAM SIMPSON,
Hon. Treasurer.

OFFICIAL LIST OF MEMBERS.

HONORARY MEMBERS.

1887 **Bodington**, Sir N., Litt.D., Vice-Chancellor, The University, Leeds.

1887 **Hughes**, Prof. T. McK., M.A., F.R.S., F.G.S., Ravensworth, Brooklands Avenue, Cambridge.

1887 **Judd**, Prof. Jno. W., C.B., LL.D., F.R.S., F.G.S., 30, Cumberland Road, Kew, Surrey.

1887 **Woodward**, Henry, LL.D., F.R.S., 13, Arundel Gardens, Notting Hill, London, W.

1907 **Woodward**, Arthur Smith, LL.D., F.R.S., F.L.S., British Museum (Natural History), S. Kensington, London, S.W.

1898 **Whitaker**, William, B.A., F.R.S., F.G.S., Freda, Campden Road, Croydon.

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* Life Members who have compounded for the annual subscriptions.

Elected.

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1907***Ackroyd**, Hy. Ed. P., Dean House, North Brierley, Bradford.

1903 **Ackroyd**, Wm., M.E., F.I.I., Nan Tan, Wortley, Leeds.

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1899 **Appleyard**, J. H. R., B.Sc., 5, Willow Lane East, Huddersfield.

1909 **Appleyard**, C. H., Calder Road, Hopton, Mirfield.

1908 **Archer**, J. Fletcher, B.A., M.I.Mech.E., 48, High Street, Doncaster.

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1900 **Ashworth**, John Hoyle, Wood Rhydding, Ilkley.

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1894*Davis, James Percy A., Old Bunting, Nqqueleni, *viâ* Umtata, Pondoland West, South Africa.
1908 Dickenson, J. H. S., 25, Fir Street, Walkley, Sheffield.
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1904*Simpson, J. T., J.P., Brackenholm, Rutland Road, Harrogate.

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1880 Tetley, C. F., M.A., Spring Road, Headingley, Leeds.

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1902 Thompson, Professor G. R., B.Sc., The University, Leeds.

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1905 Walker, W. P., Old Corn Exchange, Wakefield.

1906 Walker, William, H.M. Inspector of Mines, Doncaster.

1884*Walmsley, A. T., M.Inst.C.E., F.S.I., F.K.C., Engineer to the Dover Harbour Board, 9, Victoria Street, London, S.W.

1894 Walton, F. Fielder, F.G.S., L.R.C.P., 19, Charlotte Street, Hull.

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1906 Wells, George John, 14, Bannerdale Road, Sheffield.

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1881*Whiteley, Fredk., Corn Market, Halifax.

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1906 Willey, Edward, B.Sc., A.M.Inst.C.E., Workington Iron and Steel Co. Ltd., Shimoga, Mysore State, India.

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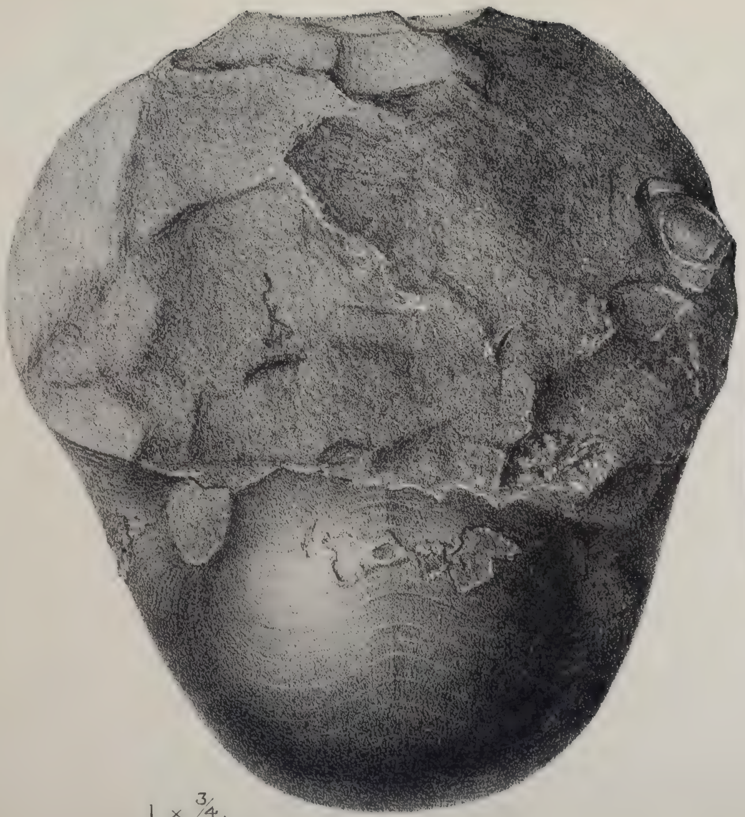
1909 Wilson, R. B., Leak Cottage, Chapel Allerton, Leeds.

1909 Wilson, G. V., Arthington Road, Pool, Leeds.

1909 Wroot, H. E., 45, Pollard Lane, Bradford.

⁂ It is requested that any Member changing his residence will communicate at once with the Hon. Secretary.



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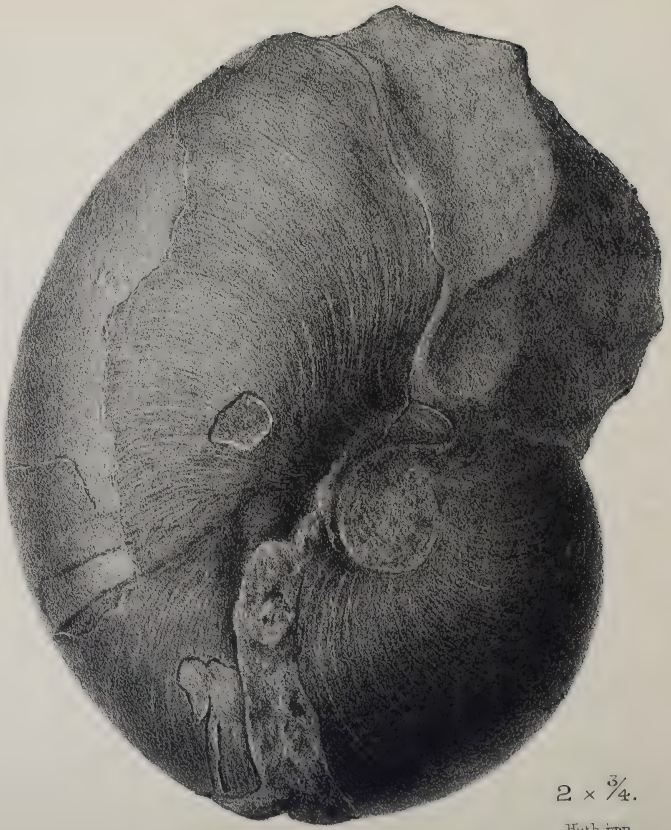

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A. H. Searle, del et lith.

Huth imp.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate III.

Vol. XVII.] Part II.

PROCEEDINGS
OF THE
YORKSHIRE GEOLOGICAL SOCIETY.

Edited by W. LOWER CARTER, M.A., F.G.S.

1910.

ON FOUR NEW CARBONIFEROUS NAUTILOIDS AND A GONIATITE NEW TO GREAT BRITAIN.

BY WHEELTON HIND, M.D., B.S., F.R.C.S., F.G.S.

(Plates III.—VII.)

(*Read March 4th*, 1910.)

INTRODUCTION.

The specimens which form the subject matter of this paper have either been collected by or loaned to me for study and description. Some of them have been in my hands for years, during which I have compared them with figures and descriptions of most of the described Carboniferous species. I have also had the advantage of showing the specimens to Mr. G. C. Crick, of the Natural History Museum, and of conferring with him on their structure and affinities. During the last year I have been able to learn that my specimens were not unique, but that other examples of the same genera and species were extant in public and private collections, it therefore seemed to me that it was a fitting time to publish descriptions and figures of them and to revise any previous work germane to the subject. In three cases figures of a sort had been published, under generic and specific names, which denoted characters, widely different, from those which belonged to the specimens, all of which were unaccompanied by descriptions. Two specimens, each of a different genus, were referred to *Nautilus cyclostomus*, Phill., and the other specimen, though figured, was not described or allotted a specific name. One specimen has characters which separate it from all known genera. It has therefore been necessary in this case to erect a new genus for this species for which I propose the name *Cyclonautilus*.

SOLENOCHEILUS GLOBOSUS, SP. NOV.

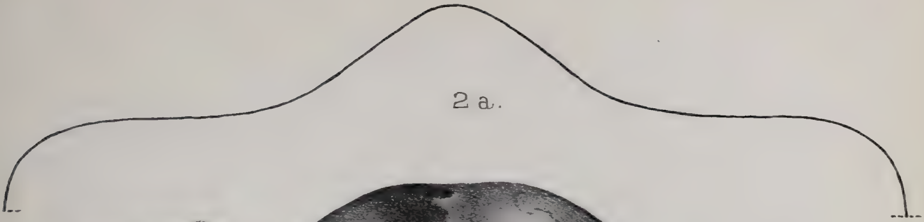
(Plates III., figs. 1, 2; IV., fig. 1).

Nautilus cyclostomus, pars, Wild, 1892, Trans. Manch. Geol. Soc., Vol. xxi., p. 379, Pl. 1, fig. 1.

Specific characters.—Shell large, globose, involute, expanding rapidly, inner whorls almost entirely concealed by the outer. The umbilicus is small and infundibuliform; its outer margin, in the older portion of the shell, angular and produced. The greatest thickness of each whorl is at the upper umbilical margin. Whorls about two and a half, inclusion large. Peripheral border of whorl almost semi-circular. The periphery broad, strongly convex, the septa are numerous, 19 are exposed in the last whorl, they become somewhat closer together as they approach the body chamber, and the chambers therefore shallower; sutures simple, with a very gentle concave curve in the middle third of the peripheral area. The body chamber is large and expanded from side to side, but flattened from above downwards. The umbilical margin strongly ridged and apparently produced. A well-marked, broad, hyponomic sinus existed.

Siphuncle is very small and placed centrally and immediately beneath the peripheral border.

Test.—Moderately thick, of several layers, ornamented by many close fine striae, arranged parallel to the margin of the aperture and showing the well marked hyponomic sinus



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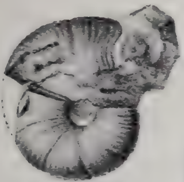

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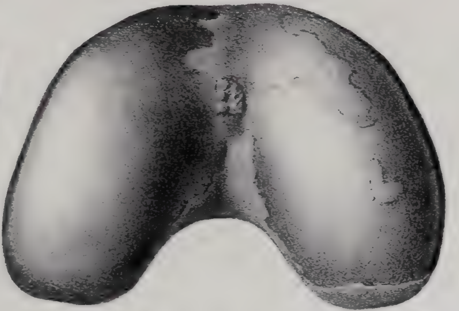

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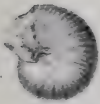

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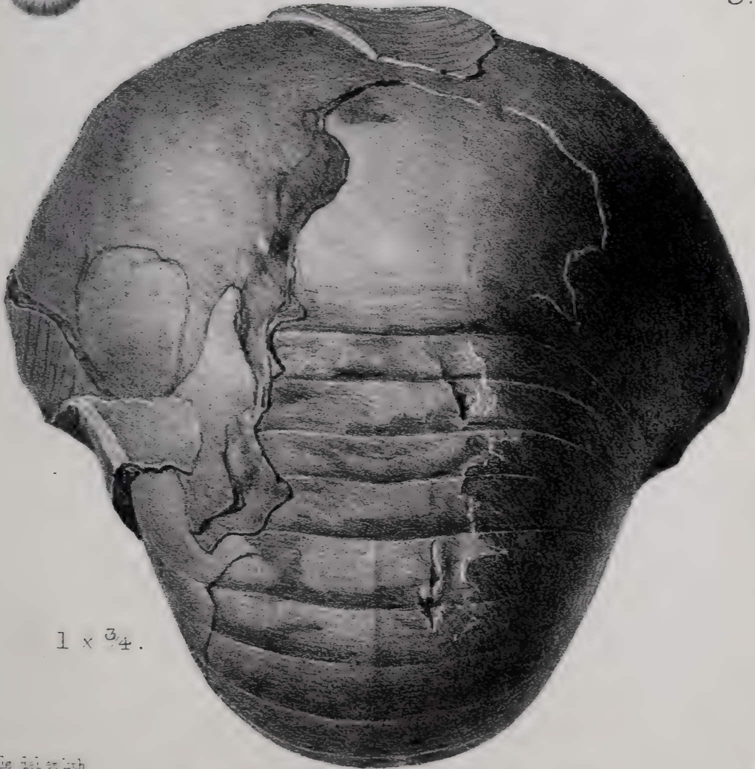

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A H Searle del et lith

Proc. Yorks. Geol. Soc., Vol. XVII. Plate IV.

[illegible]

Measurements.—Greatest diameter, 140 mm.
Length of body chamber remaining, 107 mm.
Breadth of body chamber, 128 mm.

Horizon and Locality.—Shales below Millstone Grit, Caton, near Lancaster.
Shales in Millstone Grit, Sales wheel, River Ribble, near Ribchester.
The roof of the Bullion Coal, Burnley.

Observations.—I was fortunate enough to secure a fine specimen of this species, together with other cephalopods, from the locality named above at Caton. Dr. A. H. Foord, Geol. Mag., dec. iii., Vol. viii., 1891, p. 481, quotes *Pleuronautilus nodoso-carinatus*, Roemer, sp., *P. armatus*, Sow. sp., *Solenocheilus latiseptatus*, de Kon. sp., and *Actinoceras sulcatulum*, M'Coy, from the same locality. I also obtained there *Glyphioceras Phillipsi*, Foord and Crick, and *Posidoniella laevis*.

I recognised a somewhat crushed example in the Geological collection of St. Mary's College, Stoneyhurst, from the Millstone Grit shales of Sales wheel in the bank of the Ribble where it is associated with *P. falcatus* sp. J. de C. Sow., sp. *Glyphioceras bilingue*, Salt, sp., *Orthoceras*, sp., *O. asiculülare*, Brown, fragments of what I take to be *Pleuronautilus nodoso-carinatus*, Roem., sp., *Pterinopecten papyraceus*, Sow., sp., *Pseudamusium fibrillosum*, Salt, sp., *Chaenocardiola footii*, Baily, sp., and *Posidoniella laevis*, Brown, sp.

The Sales wheel shales are referred to the horizon of the Sabden shales, overlying the Kinderscout or 4th grit. The zone Goniatite is *Glyphioceras bilingue*, Salt, sp., which ranges from the upper part of the Pendleside group to the Sabden shales.

The Caton shales are probably about the same horizon.

I also found the body chamber of a full sized example of the species in the Marine series of Congleton Edge, 600 feet below the Millstone Grit in the zone of *Glyphioceras spirale*. An examination of the fine specimen in the Manchester Museum, which I think is the one figured by Wild, Op. supra cit., convinced me that he had not only erroneously referred two forms to *N. cyclostomus*, Phillips, sp., but had confounded together two Nautiloids of very different habit and characters, as evidenced by their suture lines. He had, if I am correct in thinking that the specimen I mention is the one figured, also added details to the figure which were not shown in the specimen, and invented a suture line which the shell did not possess. The shell is almost the same size as the figure, it bears a label in Mr. Wild's own handwriting giving the horizon and locality Carre Heys, Burnley, Bullion Coal. It shows well one feature of the drawing, the median ridge along the centre of the periphery.

The test is present in the greater part of the shell, especially at the commencement of the last whorl, and the sutures are not to be seen in that part of the shell as shown in Wild's figure, but nearer the body chamber the sutures are seen to be simple, transverse, and without a central saddle. I am informed by Mr. Wilkinson, of the Manchester Museum, that the specimen marked No. 15 is in the Kay Shuttleworth collection, and not in the Wild collection, and that Wild was known to have complained that he was unable to procure the return of specimens loaned to Burnley. I recollect seeing a large Nautiloid shell, which I think is the one in question, at Mr. Wild's house many years ago. I would call attention to the improbability of the small number of sutures shown in the figure (*Op. supra cit.*) being correct, only five are shown about $\frac{3}{4}$ inches apart. This specimen is about the same size as the Caton example, but much better preserved. The broad periphery and the large amount of inclusion distinguish the species from *S. dorsalis*, Phill., sp., *S. hibernicus*, Foord, and *S. latiseptatus*, de Kon. Dr. Foord has given the name *S. caledonicus* to a sub-globose form from Arden Quarry, Nitshill, near Glasgow, and I should suspect that horizon to be not far from that of the Caton brick shales; and moreover Arden Quarry has afforded specimens of *Pleuronautilus nodoso-carinatus*. In *S. hibernicus* Dr. Foord states that the siphuncle is central, which is not the case in the new species. I have been somewhat struck by the angular margin of the aperture, and the question of the affinity of the species to *Acanthonautilus*, Foord, occurred to me, The shell differs entirely in its habits from *A. bispinosus*, Foord, and it does not seem that the ridge, at the margin of the umbilicus, is going to be folded and produced into a spine. Dr. Foord says in his generic description of *Solenocheilus*, Cat. Foss. Cep. Brit.

Mus., Pt. ii., p. 166, "The umbilical shoulders project in heavy ridges."

CYCLONAUTILUS, GEN. NOV.

Nautilus, Wild, 1892, Trans. Manch. Geol. Soc., Vol. xxi., Pl. 3, fig. 17.

Generic description.—Shell involute, 2-3 whorls, the last almost completely covering the others. Umbilicus small, deep. The margin, erect and angular in the young part of the shell, becomes carried outward so as to present a bevelling of that part of the umbilical margin interior to it.

The chambers are comparatively large. The suture has a broad median peripheral sinus with bluntly curved narrow saddle at each peripheral margin, along the side of the whorl is a broad concave sinus, and an angular saddle at the umbilical margin.

Observations.—The suture line has a close similarity to that of *Metacoceras*, Hyatt, but this genus has a wide umbilicus, which exposes all the whorls and the majority of the species possess tubercles at the peripheral margin. The genus is founded on a specimen in the Wild collection in the Manchester Museum. The specimen was figured by Wild op. supra cit., as *Nautilus* nov. sp. The specimen bears a label in Wild's handwriting with reference to the figure, and has the name *Nautilus cyclostomus* on it in manuscript. The figure differs from the present specimen in many details. The form of the margin of the aperture, the extent of the body-chamber. It does not show the prominent umbilical margin, but depicts the inner whorls which are not exposed in the specimen. In spite of these facts judging from the comparison of some of the other figures on the plates with their originals, I think there can be no doubt that the figure is intended for the specimen I now describe.

CYCLONAUTILUS UMBILICATUS, SP. NOV.

(Plate VI., figs. 3, 3*a*, 3*b*.)

Nautilus, nov. sp., Wild, 1892, Trans. Manch. Geol. Soc., Vol. xxi., Pl. 3, fig. 17.

Specific characters.—Shell compressed, globose, sub-circular, the whorls involute, the last almost completely hiding the preceding ones, very gradually increasing in breadth and depth. The umbilicus is small and deep, and its shoulder bevelled in the older chambers and more so on the body chamber. The body chamber is incomplete in the specimen, but measures 77 mm. in length. It increases rapidly in breadth, and the umbilical shoulder becomes everted and prominent. On its periphery are obscure transverse undulations. The aperture is 59 mm. from side to side, and 49 mm. in height, somewhat flattened at the central part of the periphery. The chambers are comparatively large, 10 in the last whorl. The sutures are described under generic characters, the characteristic sinuses and saddles become more marked in the older part of the shell. There is a flattening of the periphery to be seen in the whole of the last whorl ; the sides are gently convex. The cast of the interior shows a linear elevation in the centre of the periphery.

Locality.—The roof of the Bullion Coal, Burnley.

Observations.—This specimen unfortunately shows no details of the margin of the aperture or the first whorl. The angularity of the saddles of the suture line increases with each whorl.

APHELECERAS LATUM, SP. NOV.

(Plate VII., figs. 1, 2, 3.)

This species is founded upon two examples of the chambered portion of the shell and commencement of the body chamber, and one small fragment of another individual.

One specimen was given to me by Mr. J. Dunn, who procured it from the Comb or 4 Laws Limestone of Redesdale ; the others are in his possession, and one of them is much larger than the specimen I figure.

Specific characters.—Shell large, evolute, with the aperture only just in contact with the preceding whorl ; rapidly increasing in diameter. Central vacuity large. The greatest thickness of each whorl is at the peripheral margin. Whorls in this specimen two and a half to the commencement of the body chamber inclusion none.

Umbilicus large, exposing all the whorls. Whorl lunate in section, much wider than high, lower border convex; periphery broad, gently concave, the margin acutely angular, sides very gently convex.

The septa are very numerous and deeply concave. The sutures have a deep backward curve on the periphery and also on the sides. Test was thin and marked by fine parallel striae.

In the nepionic and neanic stages the test is ornamented by longitudinal lines. Apparently in the nepionic stage the whorl is free. The fragment is 95 mm. in diameter, and the breadth of the periphery 50 mm.

Affinities.—A. Mutabile, M'Coy (Synopsis, Carb. foss. Ireland, p. 18, Pl. iii., fig. 7), and *A. Hibernicum*, Foord and Crick (Geol. Mag., Dec. iii., Vol. x., p. 251, woodcut, p. 254) are much too discoidal and compressed to be mistaken for *A. latum*. *A. trochlea*, M'Coy (Synopsis, Carb. foss. Ireland, p. 19, Pl. iii. fig. 4), of which only fragments are known, while larger than either of these species, has its whorl much higher and not nearly so broad as *A. latum*. It is probable that *A. trochlea* comes from a lower life zone than any of the other species of the genus, fragments having been obtained at Kendal, probably from Seminula beds and also from Tyrone. On the other hand, *A. mutabile*, *A. hibernicum*, and *A. latum* have all been obtained from upper Dibunophyllum beds. De Koninck, however, figures a fragment of *A. trochlea* from Visé.

A. difficile, De Koninck (Faune, Calcaire, Carbonifere, Belgique, 1878, Pt. 1, p. 118), and *A. discoideum*, De Koninck, sp. (op. supra cit., Pl. 33), have a closer affinity to *A. mutabile* than to the species now under discussion.

The cephalopod fauna associated with *A. latum* in the 4 Laws Limestone contains the following species:—

Stroboceras bisulcatum, De Koninck, sp.
Cœlonautilus derbiense, Foord.
C. planotergatum, M'Coy, sp.
C. cariniferus, Sow., sp.
Coloceras coyanum, D'Orbigny, sp.
Solenocheilus dorsalis, Phillips, sp.
Actinoceras breynii, Martin, sp.
Actinoceras giganteum, Sow., sp.

EPHIPPIOCERAS WILDI, SP. NOV.

(Plates IV., figs. 2, 2*a* ; V., figs. 1, 2 ; VI., fig. 1.)

Nautilus cyclostomus, pars Wild, 1892, Trans. Manch. Geol. Soc., Vol. xxi., p. 397, Pl. 2, fig. 2.

Specific characters.—Shell of medium size, globose, not rapidly expanding, involute. Whorls about three, the inner almost entirely covered by the succeeding one. Umbilicus deep, infundibuliform, its margin rounded. The periphery is broadly convex, somewhat flattened at its middle third. The sides convex. The chambers are reniform in section, and comparatively large, the suture has a well marked ventral saddle. The body chamber is elongate, somewhat depressed, and expanded from side to side at the aperture, which possesses a strong and well marked hyponomic sinus. The siphuncle is large and median.

The surface of the shell is almost smooth, but fine lines and striae of growth are visible when the surface is viewed with the low powers of a microscope. Shell of moderate thickness, composed of several layers.

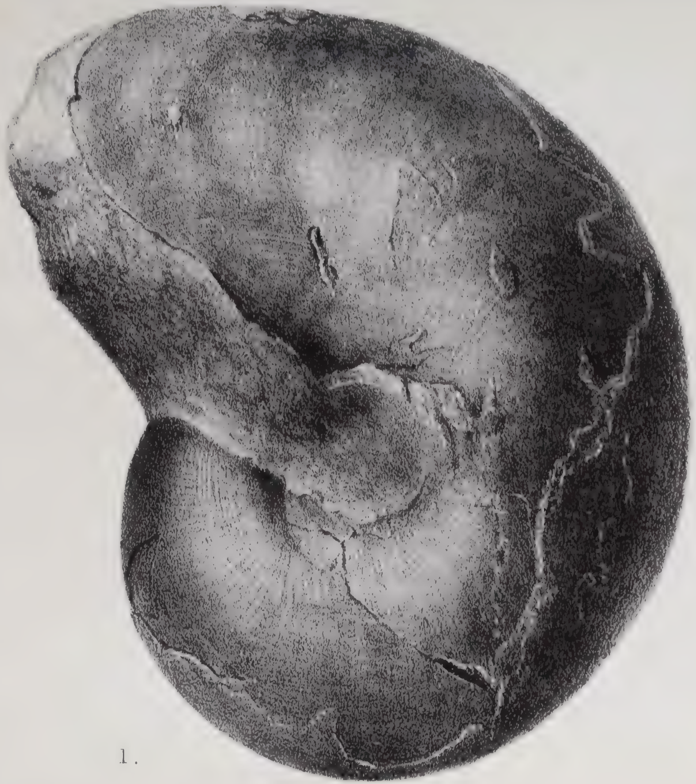
Localities.—The horizon of the Bullion Coal, Carre Heys, Colne ; Burnley and Halifax ; Shore near Littleborough ; and Sholver, near Oldham.

Dimensions.—A complete specimen in the Kay Shuttleworth collection in the Museum of the Manchester University measures :

Greatest diameter, 107 mm.
Length of body chamber, 138 mm., on the curve at the side.
Breadth of the body chamber, 83 mm.

Observations.—This species is represented by a number of examples of the body chamber, and three fairly complete specimens, in the Manchester Museum of the Manchester University, and I am indebted to Prof. Boyd Dawkins for permission to study them. I have in my collection two specimens of the body chamber and one showing in addition a part of the inner whorl.

Mr. Wild figured the body chamber op. supra cit., and referred the species to *Nautilus cyclostomus*, Phillips, from which it is at once distinguished by the deep central saddle in the suture,



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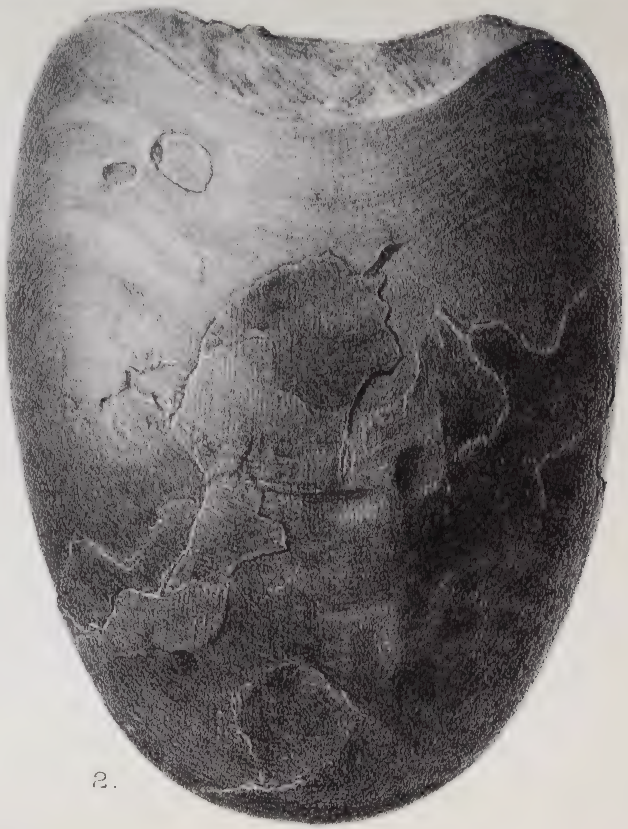

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Proc. Yorks. Geol. Soc., Vol. XVII., Plate V.

Huth, imp.

a character which shows that it belongs to the genus *Ephippioceras*, Hyatt. Wild, in the same paper, refers erroneously to *N. cyclostomus*, a large shell, which is now shown to be *Solenocheilus*, and erected into a new species, *S. globosus* (p. 98). *E. Wildi*, has been collected from a number of localities, all on the horizon of the Bullion Coal or Mountain Mine. Two other species of this genus are known from beds of Coal Measure age in England. *Ephippioceras clitallarium*, J. de C. Sow., Trans. Geol. Soc., Vol. v., Pt. iii., Pl. xl., figs. 5, *5a*, *5b*. Hind (Stobbs and Hind), Q.J. Geol. Soc., Vol. lxi., p. 541, and *E. costatum*, Foord, Cat. Foss. Ceph. Brit. Mus., Vol. ii., p. 103, fig. 14, both of which are much more globose, much smaller and more involute, the median saddle of the suture is broader and comparatively less elevated, and the body chamber shorter and more expanded transversely.

E. bilobatum, Sow., sp., occurs in the (?) Calciferous sandstone series of Closeburn, Dumfriesshire ; it is more nearly related to *E. clitellarium*, Sow., sp., than to *E. Wildi* in general shape.

I have referred a specimen in my collection from the Millstone Grit of Hazel Hill, near Ripon, to *E. bilobatum*, but there is no doubt that the genus is present at that horizon (Life Zones in Brit. Carb. rocks, Naturalist, 1907, p. 17).

There occurs in the Silica quarry at Congleton Edge, almost 600 feet below the base of the Millstone Grit, a marine band in the zone of *Glyphioceras spirale*, a large *Ephippioceras* with a somewhat acute saddle in the suture, not *E. Wildi*, but owing to the fragmentary condition of this specimen, I hesitate to speak more definitely at present. This genus is represented in the Coal Measures of Kentucky, U.S.A., by *E. ferratus*, Cox, sp. (Geol. Soc. Kentucky, Vol. iii., p. 574). Hyatt refers *Nautilus divisus*, White and St. John (Descr. Fossils, etc., Trans. Chicago Acad., Sec. i., p. 124), from the Lower Coal Measures of Kansas and Texas to *Ephippioceras*. This form is somewhat larger than *E. Wildi*, the body chamber more transverse, and the saddle of the suture broader and less elevated.

Nautilus montgomeryensis, Worthen, Geol. Surv. Illinois, Vol. viii., p. 148, Pl. xxvi., fig. 2 ; Pl. xxvii., fig. 1, from the Coal Measures of Illinois, has a median saddle more like that of *E.*

Wildi, but this shell has a different habit altogether, increasing rapidly in its transverse diameter and being much more expanded from side to side than the species under discussion.

GLYPHIOCERAS VESICULIFER, DE KONINCK, SP. 1880.

(Plate VI., figs. 2, 2*a*, 2*b*.)

Goniatites vesiculifer, De Koninck, 1880, Faune du Calcaire Carbonifere de la Belgique, p. 109, Pl. xlix., figs. 10, 11.

Specific characters.—Shell small, involute, comparatively broad for its height. Umbilicus small and steep, margin very gently bevelled at the expense of the edge. The periphery is broad, gently convex, separated on each side from an inflated margin by a longitudinal sulcus. Below the rolled margin the side of the whorl is flattened and depressed.

The suture line is drawn from the specimen.

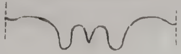
Ornamentation.—The sides of the shell are adorned by a number of small, slightly elevated curved radiating costae, which pass from the edge of the umbilicus and become lost on the swollen band. Between the ribs the lateral surface is covered with numerous regular longitudinal lines. The surface of the inflated margin is finely punctate. Test thin.

Dimensions.—The shell, which is incomplete, and lacks entirely the body chamber, measures :—

From side to side at the inflated margin, 13 mm.
Greatest vertical diameter, 21 mm.

Localities.—The Carboniferous Limestone of Elbolton, near Cracoe, Yorkshire (Upper Dibunoplyllum zone). De Koninck states that he found this species at Settle (op. supra. cit.).

Observations.—The peculiar swollen peripheral margins and the flattened depressed sides of this shell at once distinguish the species from all other described forms. De Koninck bases his description on specimens from the Carboniferous Limestone of Visé, but his specimens did not show the ornamentation of the shell and the well-marked curved costae on the flat lateral surface. He described the swollen peripheral margin as being formed of small vesicles, and it seems apparent that such was the case, for these bands do not appear on that part of my specimen, which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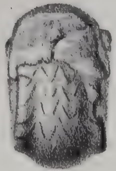
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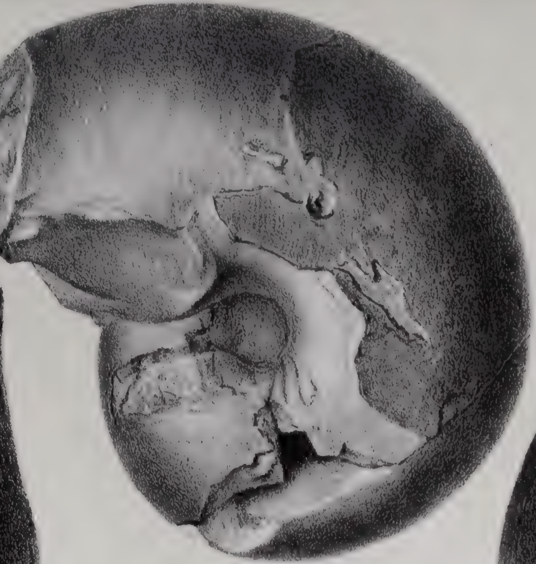

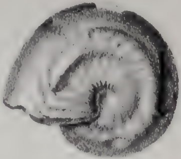
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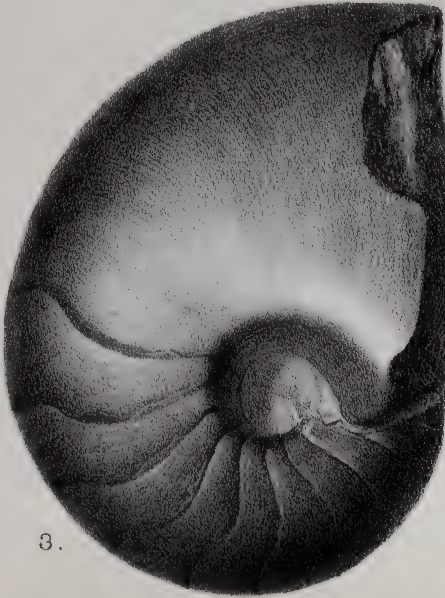
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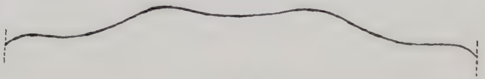
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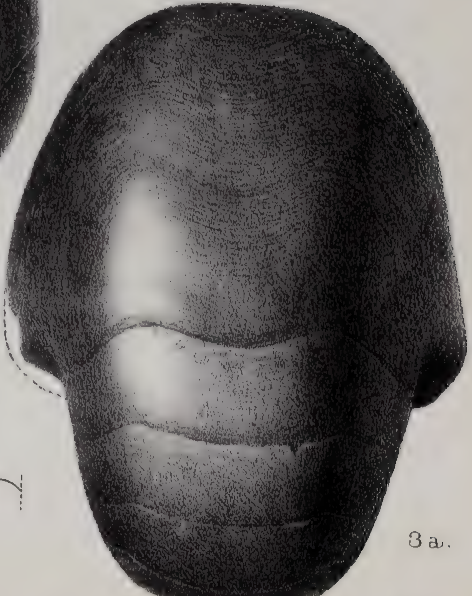
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A. H. Searle, del et lith.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate VI.

Huth, imp.

represents a cast of the interior. He figures the surface of this fold as being punctate, a fact which my specimen substantiates.

I regard this species as being very rare, the specimen I now figure being the only one I have ever found during many years' work in the Carboniferous Limestone of Great Britain and Ireland.

PERICYCLUS MINIMUS, SP. NOV.

(Plate IV.)

Specific characters.—Shell small, discoidal involute, expanding gently. Inner whorls almost completely concealed by the outer. The umbilicus is comparatively small and shallow, its outer margin rounded. The greatest thickness of the whorl is at the umbilical margin. Whorls 3, 4, strongly convex at the periphery, moderately so at the sides. Whorls not numerous, body chamber large, in one specimen occupying three-quarters of a whorl. The suture has not been seen. The whorl is marked by three or four well-marked transverse constrictions. The aperture has a shallow peripheral sinus.

The test is of moderate thickness, ornamented by numerous regular, rounded, transverse ribs. The ribs are thicker on the sides, and either bifurcate as they pass over the periphery, or a rib, which does not reach the sides, is interpolated. On the periphery the ribs have a shallow broad sinus.

Dimensions.—Fig. 3. Pl. IV., measures :—
Greatest diameter, 22 mm.
Breadth of body chamber, 9 mm.

Locality.—The Carboniferous Limestone of Thorpe Cloud, Derbyshire.

Observations.—A number of specimens of this species are in my collection, many of them much smaller than these figured. The general character and ornament of the shell show marked affinity to the Genus *Pericyclus.* Unfortunately, in no case is the suture line exposed.

This species is very much smaller than any other referred to the genus.

P. impressus, De Koninck, has some resemblance to the species under discussion, but its transverse ribs do not bifurcate and do not become stronger on the sides of the shell. The same character also separates the species from *P. vergatus*, De Koninck.

EXPLANATION OF PLATES.

Plate III.

Fig. 1.—*Solenocheilus globosus*, a complete specimen, from the roof of the Bullion Coal, Burnley, in the Geological collection of the Manchester Museum, p. 100.

Fig. 2.—*Solenocheilus globosus*. The same specimen, lateral aspect.

Plate IV.

Fig. 1.—*Solenocheilus globosus*, a specimen showing the septa and camerae from shale, just below the Millstone Grit, Caton, Lancashire. My collection, p. 99.

Fig. 2.—*Ephippioceras Wildi*, the camerae end of the body chamber, showing the siphuncle. From the roof of the Bullion Coal, Burnley. My collection, p. 105.

Fig. 3.—*Pericyclus minimus*, a specimen from the Carboniferous Limestone of Thorpe Cloud. Lateral aspect. My collection, p. 107.

Figs. 4, 5 and 5A.—*Pericyclus minimus*, younger specimens. Same locality and collection, p. 107.

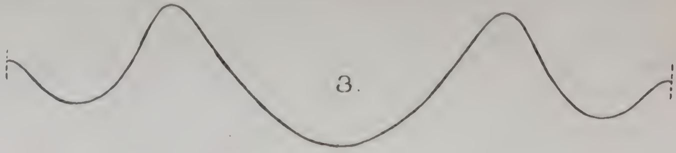
Plate V.

Fig. 1.—*Ephippioceras Wildi*, a complete specimen from the Bullion Mine, Burnley. In the Geological Collection of the Manchester Museum, p. 104.

Fig. 2.—*Ephippioceras Wildi*. A view of the body chamber, peripheral aspect.

Plate VI.

Fig. 1.—*Ephippioceras Wildi*. A specimen from the roof of the Mountain Mine, Sholver, nr. Oldham. In the Geological Collection of the Manchester Museum, p. 104.



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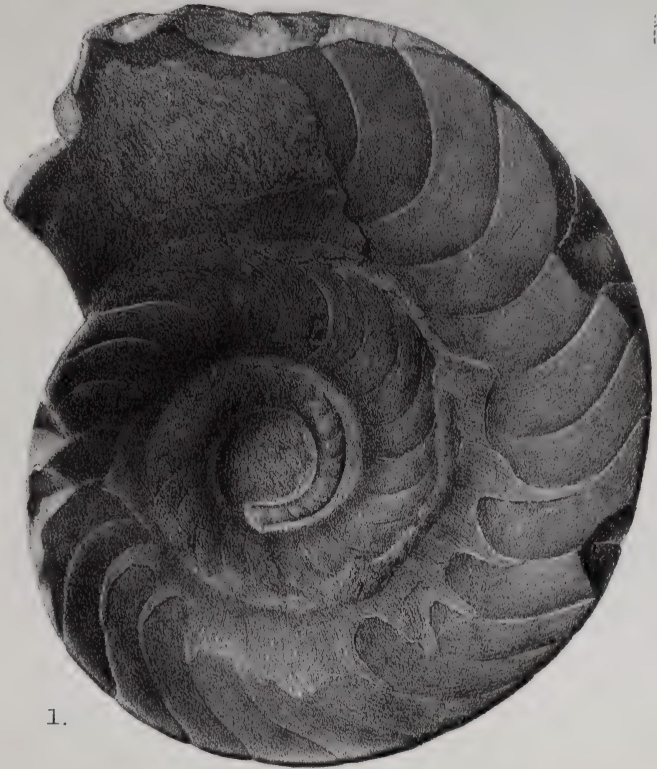

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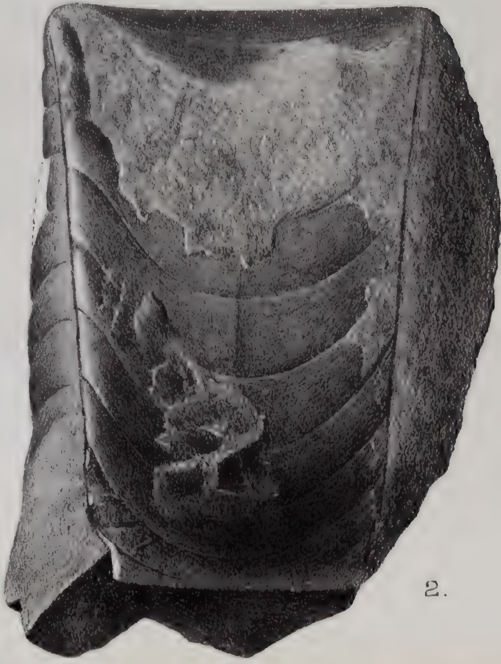

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Proc. Yorks. Geol. Soc., Vol. XVII., Plate VII.

Huth imp

Fig. 2.—*Glyphioceras vesiculifer*, from the limestone of Elbolton, Cracoe, Yorkshire. My collection, p. 106.

Fig. 2A.—*Glyphioceras vesiculifer*. A view of the periphery and sutures, with 2B the suture line.

Fig. 3.—*Cyclonautilus umbilicatus*. A specimen from the roof of the Bullion Coal, Burnley. In the collection of the Manchester Museum, p. 101.

Fig. 3A.—*Cyclonautilus umbilicatus*. A view of the periphery and body chamber.

Fig. 3B.—*Cyclonautilus umbilicatus*. The suture line.

Plate VII.

Fig. 1.—*Apheleceras latum*; 4 Laws Limestone, Redesdale. Viewed from the side showing the chambers. My collection, p. 102.

Fig. 2.—*Apheleceras latum*. View of the periphery.

Fig. 3.—*Apheleceras latum*. The suture line.

THE COMPLEX OF IGNEOUS ROCKS AT OATLAND, SANTON, ISLE OF MAN.

BY FRANK W. WHITE.

(Plates VIII.—XI).

(*Read 4th March,* 1910.)

INTRODUCTION.

The field relations of this complex of igneous rocks have been described by Mr. G. W. Lamplugh, F.R.S., in the Survey Memoir, "The Geology of the Isle of Man" (1903). Petrological notes by Prof. W. W. Watts, M.A., F.R.S., are also included in the volume.

A description of the acid type of rock at Oatland, as revealed by one thin section, had previously appeared under Mr. B. Hobson's name in Vol. XLVII. of the Q.J.G.S., and, later, in "Yn Liaor Manninagh" for 1892 (Vol. I., pt. 10).

Dr. F. H. Hatch briefly refers to the occurrence in his "Text Book of Petrology" (1909), pp. 285-6.

FIELD RELATIONSHIPS.

This igneous complex near Santon, in the S.E. part of the Isle of Man, is intrusive into the thinly-bedded Lonan Flags of the Manx Slate series. The Flags are visible on the East, West, and South-East in the immediate neighbourhood of the igneous mass, and have there been altered by the intrusion to a baked and splintery character. They are minutely spotted and banded, and, under the microscope, appear to consist of fine clastic grains of quartz in an aggregate of fine flakes of mica set in a groundmass of chlorite.

The structural axis of the Island runs N.E.-S.W. from Maughold Head east of Ramsey, through Foxdale to the Calf of

Man, and though the dip and strike of the bedding are extremely complicated, that of the main cleavage is fairly persistent and uniform over wide areas. The general dip of the cleavage in the "slates" is towards the S.E. on the eastern side of the structural axis of the island. For some considerable distance along the coast-line east of Oatland the cleavage dip is 60°, and at places about midway between Oatland and Foxdale on the W. it has the same direction and amount. At Oatland, however, the dip is only 30° to the S.E. on the eastern side of the intrusion, while on the western side the direction of the dip is reversed.

The actual junction of the igneous rock and the slates is nowhere visible at present (1909).

The intrusive rock itself is exposed in a quarry for road-metal in the centre of the mass, and in very low crags of small area on all sides. The boss is probably of nearly an oval shape where it reaches the surface, the outcrop showing a length of nearly 900 yards from N.E. to S.W., and a breadth of nearly 300 yards from S.E. to N.W. The longer axis is therefore parallel to the structural axis of the island.

Near the centre of the boss a small fault runs in nearly a N.W.-S.E. direction, but this was the only sign noticed of any mechanical disturbance of this character.

At the centre the rock appears to be a pale, mottled greenish-grey, close-textured "granitite," showing chlorite, felspar and quartz, and an occasional speck or two of pyrites.

But on the outskirts of the boss, in the low crags, the rock is dark-green, with large crystals of augite or hornblende. Pyrites occurs more frequently. The rock resembles many others in the island, and may provisionally be termed a diabase.

In the deepest and most central part of the granitite, opened out recently, were found a few rounded knobs of the diabase as xenoliths, and, near the margin of the quarry, especially on the north-eastern side, were many sub-angular fragments of the same basic rock included in the granitite.

Some of the crags of basic rock are traversed by veins of the granitite, which thin out and become finer towards the circumference of the mass.

The basic and acid rocks probably have therefore a circumferential junction, though the main junction has not apparently been yet exposed. It is also clear that the basic rock was intruded prior to the more acid rock, though how long an interval elapsed between the intrusions remains to be determined.

Just south of the small fault in the granitite is a very narrow (about 2 ins.) and almost vertical dyke of greenish quartz associated with pads of a soft green, fibrous, asbestos-like mineral (actinolite ?) which closely resembles the " fibrous tourmaline " (Memoir), which occurs in similar veins in the Dhoon granite in the N.E. of the island. This quartz dyke appears in the quarry apparently striking to the N.E., and in a low crag of the basic rock cropping out in the adjoining field in this direction the vein was again found visible traversing both the diabase and the veins of granitite, and associated with the same fibrous mineral.

The granitite at the southern end of the quarry is very soft, decomposed and stained.

A rock which closely resembles a certain facies in the Oatland complex is visible about two miles to the N.N.E., near Ballabunt, and it is noteworthy that rocks with similar affinities occur as bosses in St. Michael's Island, and Langness, also in dykes running N.E. and S.W. along the coast to the east of Oatland.

AGE OF THE INTRUSION.

Unlike the Foxdale granite, and still more unlike the Dhoon granite, the rock at Oatland shows practically no sign of shear movement, and may be ascribed to a somewhat later date. This is confirmed by the effect the igneous mass has had in altering the dip of the cleavage in its vicinity.

But even the most basic modification at Oatland gives no evidence of the presence of either the monosilicate or bisilicate of magnesium, and, in the writer's knowledge, it resembles all the undoubtedly pre-Carboniferous intrusions of the island in this respect, but for the same reason is likewise in strong contrast to the olivine-bearing extrusions and intrusions of Carboniferous or Tertiary age. This would still leave the age of the intrusion of the granitite an open question as evidence seems to point to the lapse of a considerable interval between the intrusion of the more basic and more acid types in the complex.

For a similar reason, and in view of its close identity with the more basic facies at Oatland the age of the smaller intrusion at Ballabunt is considered to be contemporaneous with the earliest intrusion at Oatland.

DETAILED DESCRIPTION OF THE ROCKS.

A series of thin rock-sections made from specimens taken in various directions revealed the fact that a gradation in character is fairly constant from the most acid to the most basic type. For convenience of description, however, the complex may be resolved into three types of rock, acid, intermediate and basic. Among other considerations, which will be apparent later, we hold the acid facies to be distinguished by the presence of orthoclase, and the basic by the absence of original quartz. The most acid type is found in the centre of the boss, and there is a fairly constant increase of basic characteristics as one proceeds to the margin, although it is not possible to fully test this in every direction, and the megascopic examination of the rocks in the field indicates an increasingly rapid assumption of basic character towards the periphery.

1. ACID TYPE.

(Plate VIII).

The rocks in this section are mostly adamellites, monzonites and granodiorites. They are, however, all characterised by the presence of a considerable amount of quartz, with idiomorphic plagioclase, varying quantity of orthoclase, chlorite pseudomorphs after biotite and a little hornblende. In each case the characters of the minerals will be described in the order in which they appear in the specimens arranged in a series of decreasing acidity.

Quartz.—This has been the last mineral to crystallise. It resembles that of the Foxdale granite in having the granitic habit, while that of Dhoon and the Crosby microgranite (an elvan of the Foxdale mass) is quite granular. It should be remarked, however, that one section shows it as granitic and locally granular, another as mostly granular, and a third as having some undulose extinction. This is probably due to a merely local movement at the time of consolidation. The quartz has the habit of completely surrounding the other minerals and occasionally encloses sub-angular fragments of its own species. Fluid pores arranged lineally or in strings increase in number and size from very few to very many. Some contain gas cavities. Staining with iron-ore is shown between some of the crystal faces. Inclusions become more and more numerous, comprising apatite, small flakes of muscovite probably derived from the orthoclase, zircon, epidote (sometimes as disconnected granules in parallel strings, perhaps derived from neighbouring hornblende), zoisite, some large crystals of iron-ore, and an unidentified mineral which appears in two specimens. This latter mineral is of irregular outline and colourless. It has no fluid pores; against it the quartz with its crowd of fluid cavities is everywhere arrested, but it contains one or two negative octahedral crystals, probably of fluid. It is chatoyant by reflected light, is isotropic, and has a refractive index about equal to that of quartz, greater than felspar, and less than biotite.

Measuring off the intercepts of the minerals by Rosiwal's method in the various sections, and calculating their gravimetric proportion in the rock, it was found that quartz decreases from 37 per cent. to 18.4 per cent. in this acid facies.

Orthoclase is always present, but in varying quantity. Its outline is usually irregular as in other Manx granites.

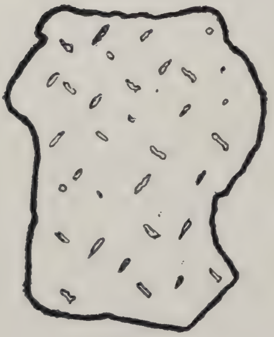


Fig. 1.

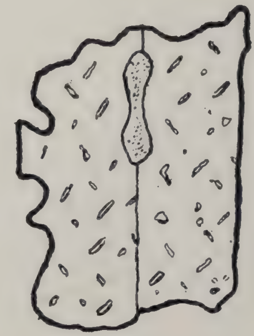


Fig. 2.

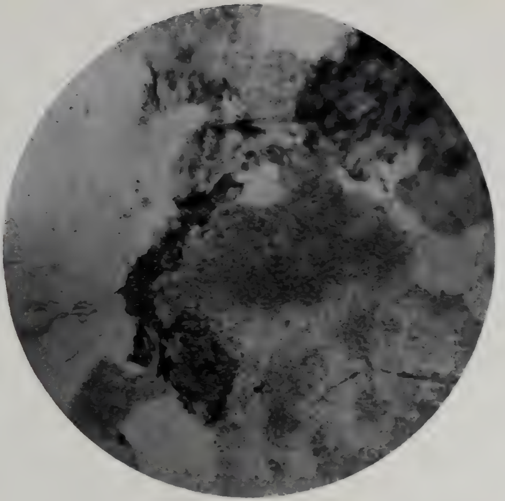


FIG. 1.

Oatland Complex. Acid Facies. × ***20.***

Much granitic quartz, with a few inclusions of apatite: some plagioclase and corroded orthoclase, also a granular aggregate of epidote, probably after biotite.

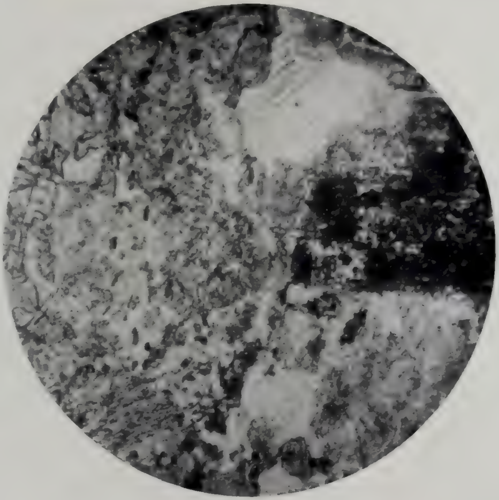


FIG 2.

Oatland Complex. Junction Specimen. × ***20.***

The portion of the basic xenolith shows an allotriomorphic aggregate of secondary minerals, the fibrous hornblende having a tendency towards the actinolitic habit.

Bordering the xenolith is much clear quartz and a large crystal of decomposed plagioclase.

(Photographed by W. L. Carter.)

Carlsbad twinning is common, and quartz has sometimes been forced along the twinning plane (Fig. 2). Some of the larger crystals were measured, the dimensions being 2.75 × 2.35 mm., 2.31 × 1.6 mm., 3.78 × 1.45 mm., and 2.5 × 1.25 mm. In the granodiorite the average size would be about 1.4 × .65 mm. There are inclusions of apatite, usually surrounded by iron-ores, grains of magnetite, and a few patches of chlorite. The orthoclase becomes increasingly turbid by decomposition, the products of which, in addition to amorphous matter, are flakes of muscovite which lie nearly normal to each other in some sections (Figs. 1 and 2), and parallel to the sides of the crystal in others. The included iron-ores are sometimes altering to sphene. Clear bipyramidal quartz is an occasional decomposition product. The turbid orthoclase often has a narrow rim of clear felspar substance. When orthoclase and plagioclase are in contact it is evident that the former has always crystallised prior to the latter.

The gravimetric proportion of orthoclase in this facies decreases from 28 per cent. to 6.1 per cent. of the whole rock.

Plagioclase usually shows more regular outlines than orthoclase, and has the habit of projecting into the quartz. The pinacoids show especially good faces, but some faces are apparently corroded by quartz. There are some larger crystals measuring about 2.0 × 1.15 mm., but the average sizes vary from about .72 × .4 mm. to 1.1 × 9 mm. Twinning according to the albite law is common, but there is a gradual assumption of pericline twinning as well. The width of the lamellae in the former type becomes slightly increased. The maximum extinction angles, measured from the twinning-planes show a gradual increase from about 11° to about 16°. The felspar is probably an oligoclase-andesine, but in all the specimens there are some crystals of apparently a medium oligoclase. The individuals are turbid with decomposition products, but usually have borders of fresh felspar substance, sometimes at the ends, sometimes—usually when quartz is adjacent, at the sides as well, and sometimes at the ends and in interior patches. It is considered that the fresh felspar is more acid when added to the ends than that on the sides, and still more than that in interior patches. The new growth of felspar round the borders exactly resembles that round the plagioclase in the Foxdale and Dhoon granites.

The decomposition product in addition to amorphous matter is mostly white mica, but much epidote occurs in places, often in veins which completely traverse some of the crystals. The flakes of white mica often project from the turbid patches into the clear felspar, and are sometimes completely surrounded by it.

There are inclusions of apatite usually surrounded by iron ore in small quantity, and iron-ore in octahedral crystals. One large enclosure is an aggregate of dusty-looking greenish-brown sphene with ilmenite, calcite and chlorite. Not only is plagioclase moulded on the orthoclase, but occasionally the former encloses in its centre small but well shaped crystals of the latter with Carlsbad twinning.

The gravimetric proportion of plagioclase in these specimens is variable, showing, in the sections examined, 39.2 per cent., 26 per cent., 36.5 per cent., 25.4 per cent., and 41.2 per cent. respectively of the total mineral content.

Biotite in greenish pseudomorphs of chlorite, with slight pleochroism, low birefringence and straight extinction, occurs with hexagonal basal sections, and longitudinal sections the ends of which are both ragged and granular. Sometimes the colour is greenish-brown, and the pleochroism becomes more marked, showing green, greenish-yellow and very pale yellow. The edges are semi-opaque with what at first sight appears to be magnetite dust, but under a higher power this seems to be due to minute granules of epidote which mutually interfere. The presence of these microscopic grains in the interior of the mineral probably gives rise to the brownish-olive colour that is occasionally presented by sections under crossed nicols. Again, crystals are often bleached, and what seem to be thorns of quartz often appear between the lamellae.

Next to chlorite, epidote is the principal product of alteration. It is in yellowish grains with pleochroism, β brownish-green, α and γ green and pale chrome. Other products are a dark-brown sphene and a blood-red haematite.

Inclusions are abundant, comprising rather large prisms of apatite and zircons up to .07 mm. in length, surrounded by pleochroic halos.

The gravimetric proportion of the chlorite pseudomorphs after biotite is very variable in the different sections in this series.

. . . .

There is another mineral present in variable quantities, "unidentified" in the Memoir, which occurs in such a fashion as to suggest its derivation from a biotite which was originally more ferriferous and titaniferous than the biotite now showing a merely chloritic alteration. It is rarely present in the most acid specimens, but becomes an important constituent in the granodioritic type.

I am indebted to Mr. A. Harker, F.R.S., for the suggestion, based on my written description, that the mineral is merely a biotite which is undergoing a change due to oxidation following chloritization.

In some sections it is frequently difficult to distinguish this mineral from the ordinary biotite. Its outline is sometimes hexagonal. The extinction is nearly straight. In longitudinal sections its ends are frequently ragged, and usually show the same pseudo "resorption border" as the biotite. Its refractive index is high, but apparently less than the chloritized biotite. In plain light it is of a turbid brownish colour and is almost opaque between crossed nicols. Its pleochroism is slight, but oblique sections show light brown and brownish-olive. Under a high power the lines of apparently opaque iron-ore are often found to be really semi-opaque brownish particles, almost ultramicroscopic in size. But in other sections they are undoubtedly iron ores, mostly leucoxene after ilmenite.

The appearance of some individuals is here illustrated.

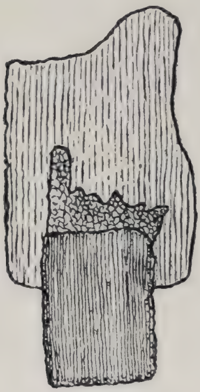


Fig. 3.

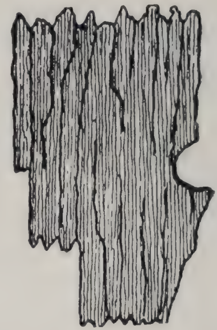


Fig. 4.

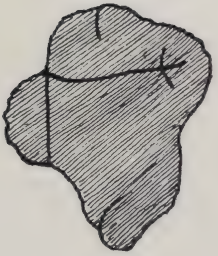


Fig. 5.

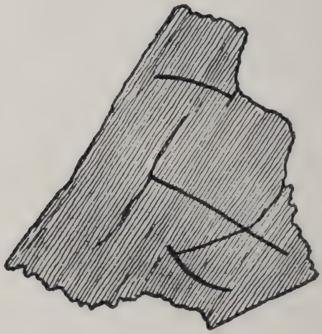


Fig. 6.

In Fig. 3 the mineral is partially enclosed by green biotite, and its end is separated from the biotite by granular epidote with pleochroism greenish-yellow and yellowish-green.

In some cases the green biotite encloses much similar epidote, and suggests that one mineral is wholly derived from the other. In other sections layers of green biotite alternate with brown layers of this mineral, the whole showing pleochroism in shades of green. The mineral is also intergrown with a bluish-green hornblende, but in such a fashion as to suggest that the latter was rather later in crystallising. However in some cases an individual of fibrous amphibole with an extinction of 15° is enclosed. Apatite in prismatic forms is the other usual mineral that is enclosed.

In the process of decomposition, besides varying amounts of epidote, there has usually been a fairly heavy separation of iron-ore, mostly titano-magnetite.

The additional fact that the biotite in the acid facies has commenced to form at about the same relative period as the more oxidised variety, which occurs in the intermediate and basic facies of the complex, affords confirmation of the micaceous character of this mineral if not of its close identity with the less altered biotite.

Hornblende is present in increasing quantity from the centre to the margin of the boss, but in the normally acid facies it does not amount to more than 7 per cent. of the total mineral content and from the most acid specimens in the facies it is nearly absent. Here it is greenish in pseudomorphs of chlorite and is usually associated with the biotite. In one case the alteration product has the structure of helminth. The crystals are sub-idiomorphic with pleochroism light-green—darker green. Its angle of extinction appears to be only about 5 degrees. It occasionally encloses many needles of a mineral which also extinguishes at 5 degrees, and in one individual these lie along three planes, thus—

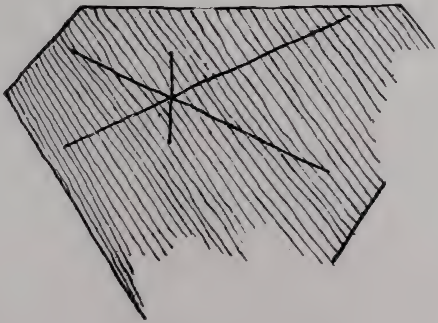


Fig. 7.

Alteration products, besides iron-ores in smaller quantity, and the usual chlorite, are secondary dark brown sphene, developing in patches, and grains of epidote. As an inclusion of original mineral, apatite is usually found.

The gravimetric proportion of hornblende in the dioritic end of the acid facies increases from 1.4 per cent. to 7 per cent. of the mass.

THE EFFECT OF THE INCLUDED BASIC XENOLITHS.

The above concludes the description of sections of the acid rocks in their normal conditions, but two sections of rock were examined showing the junction of basic xenoliths, caught up in the acid magna, with the granitic rock.

The first was taken from the deepest and most central part of the boss that was accessible and the second from the north-eastern side of the quarry. Macroscopically the former showed a rounded, the latter, a sub-angular outline.

The former (Plate VIII., Fig. 1) was found to consist of an allotriomorphic aggregate of minute chlorite, muscovite, calcite, epidote, quartz and iron-ores. Of the original minerals, biotite preserved the best forms with epidote enclosed. There were also traces of medium-sized (about .8 mm. by .8 mm.) augites now as chlorite, epidote and calcite, also some twinned hornblende and a patch of prismatic fresh-looking actinolite having the outline of a cross-section of hornblende. The quartz was in very fine threads which extinguished simultaneously over very small areas and were crowded with minute inclusions of the other minerals.

In the other section, confining one's attention to the apparent effect of the xenolith on the character of the minerals in the acid portion of the slide, it was observed that the quartz contained some unusually large crystals of iron-ore, that the amount of plagioclase present was abnormally large while one crystal of augite occurred—probably a xenocryst, with a somewhat irregular shape. Its average breadth was 1.2 mm. It was mostly uralitized, but chlorite was also present in quantity, and practically no trace of the original cleavage remained. A broad border of hornblende surrounded the kernel.

The hornblende in this part of the section closely resembled that in the intermediate and basic types in presenting two varieties, one with a pleochroism greenish-blue to pale yellowish-pink and extinguishing usually at 22 degrees and 23 degrees; the other with a pleochroism greenish-brown, brownish-green and pale straw. The latter is about three times as abundant as the former. The greenish-blue crystals are often sub-idiomorphic and contiguous to biotite. Actinolitic needles with extinction up to 9 degrees sometimes radiated from the hornblende into the biotite. The brownish-green variety in its larger patches contained some magnetite dust and suggested that it had been derived from augite or the brown hornblende usually included in it.

ORDER OF CRYSTALLISATION IN THE ACID TYPE.

The order in which the minerals commenced to form in the central or acid portion of the boss is the same in all the sections examined and is as follows:—

1. Apatite and zircon.
2. Iron ores.
3. Biotite and hornblende.
4. Orthoclase.
5. Plagioclase.
6. A little hornblende (in the less acid part only).
7. Quartz.

SUGGESTED AFFINITIES.

The chemical composition of most of the specimens, based upon the quantitative mineral composition, suggests that the most acid type resembles the composition of the "potash-granite" from Lamorne, Cornwall, and closely resembles that of the Skiddaw granite and the granite of the Mourne Mountains, while it is not far removed from the potash-soda felsite from Waterford, the Oatland rock being deficient in alumina but having an excess of magnesia.

The granodioritic type mineralogically resembles the quartz diorite from Arran, described by Zirkel, and by Teall, "Brit. Petr.," pp. 263-4.

2. BASIC TYPE.

(Plates IX., X.)

It will assist in the description of the intermediate type of rock, and save repetition, if the mineralogical features of the most basic type are next considered. The rocks in this section grade from hornblende-augite-diorites to a pyroxenite. They are all characterised by the absence of original quartz except in those parts in which there has been an intrusion of this mineral as veins or threads from the more acid magma. In such cases it has had a noteworthy effect in altering the condition of the invaded rock at the planes of junction.

Felspar is practically undistinguishable in the normal rock of this type, but in its place appears an allotriomorphic aggregate of mineral substance "undetermined" in the Memoir. The aggregate is of a dusty greenish-brown or a faint turbid brown colour. Under crossed nicols, owing to its intimate mixture with chloritised hornblende, it sometimes shows an indigo tint. The mineral has a high refractive index which, however, is less than that of either of the hornblendes and the augite. Where the granules were larger they were determined as epidote, zoisite and quartz. In a few cases where the aggregates are completely enclosed by brown hornblende they show good outlines and suggest that they are the products of an extremely decomposed plagioclase felspar. In confirmation of this, the quantity of the minerals present in the aggregates, estimated as plagioclase, was determined, and it was found that the sequence in the three facies then became intelligible. Moreover, the order of crystallisation relatively synchronised with the order as more certainly observed in the intermediate and acid types. Its original felspathic character was placed beyond doubt by the phenomena observed in a section which showed this rock invaded by a single small vein of quartz. Near this quartz the dusty mineral was found associated with fresh felspar substance. Still nearer the quartz the dusty mineral disappeared and perfectly fresh felspars were alone found. The extinction angles of these clear felspars were measured and varied from 18 degrees to 20 degrees. The original felspar was, therefore, probably an andesine.

The gravimetric proportion of the original plagioclase in the rock was found to decrease, as the basic type became richer in pyroscene towards the margin of the mass, from 36.4 per cent. to 23.6 per cent., and finally only 11.1 per cent.

Biotite in greenish pseudomorphs of chlorite is not found in this type normally. Only in the section showing the fresh quartz vein does a little appear, giving straight extinction.

The more oxidised variety occurs in small but variable quantity. However, large patches of iron-ore have in many cases the appearance of pseudomorphs of this mineral and where the original character of the mineral is more recognisable it has often set free an abnormal quantity of iron-ore—a titaniferous magnetite or ilmenite with lamellae intersecting at 60 degrees. One crystal appears thus—

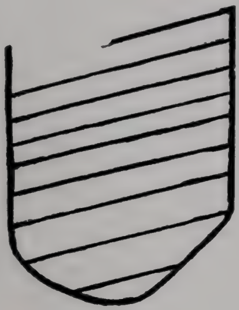


Fig 8.

The outlines of the less altered mineral are often irregular. It lies in the borders of the augite and in the hornblende and several sections measure about .35 mm. by .15 mm.

Calculating the quantities of pseudomorphs as well as the less altered mineral it was found that the proportion of this richly ferriferous biotite showed a gradual increase as the type became more basic from 2.1 per cent. to 8.2 per cent.

Hornblende occurs in two varieties, one pale green and almost colourless in ordinary light, the other giving shades of brown, greenish-brown, golden-brown to a deep yellowish ochre.

The pale green variety, now mostly chloritic, has rather a fibrous texture and usually encloses a central patch of a tangle of actinolitic blades giving extinction angles of 13 degrees, 16 degrees and 20 degrees. In the pyroxenite, however, it is only just beginning to take on the actinolitic habit. Pleochroism is very faint in shades of very pale green. The chlorite of which the mineral consists, gives, under crossed nicols, a pale indigo to brownish-green colour. The alteration product, besides chlorite, is epidote and zoisite, the former sometimes occurring in parallel strings of disconnected grains. This variety forms about 4.5 per cent. of the total mineral-content.

The brown or ochreous variety often encloses the former and cleavage traces are frequently continuous from one to the other. Its pleochroism varies from light-brown—darker brown to brownish-ochre—pale straw. It is allotriomorphic and occurs not only in isolated patches but is enclosed in streaks and grains by the augite. These, and the zones of brown hornblende surrounding the augite crystals are optically continuous with the latter. This brown variety is compact and its refractive index is higher than the chloritic. Where the former anastomoses into the latter its pleochroism changes from brownish-ochre gradually to bluish-green and green tints. The mineral is frequently in large patches, enclosing idiomorphic aggregates of felspar substance, and extinguishes simultaneously over wide areas. Some large apatites are also enclosed. This variety forms a proportion of the total mass diminishing from 18.2 per cent. to 7.1 per cent.

Near the quartz vein in the above-mentioned section the pale hornblende shows undulose extinction and the chloritic substance of which it consists, instead of showing the usual indigo in polarised light, gives an olive or brownish-olive colour. Close to the quartz the hornblende is clear, with very distinct cleavage and the iron-ore in it is streaky as though partially segregated.

Augite is the mineral most abundantly present in this type. Its form is at first somewhat irregular, approaching the quadrate in section, then outlines showing well-developed clino-pinacoidal faces appear. The dimensions of some crystals almost reach 3 mm. by 3 mm., but the average size is about 2.2 mm. by 2.0 mm.

Smaller grains are enclosed pœcilitically in the hornblende. Twinning is fairly common, but there are very few traces of cleavage left. The mineral is mostly uralitic, and often now chloritic, but frequently it appears as colourless malacolite, with refractive index greater than hornblende, extinction angles of about 44 degrees, and strong birefringence. In one section there is an approach to the diabase type with a few crystals of felspar in a granular state, but with fair outlines enclosed in the marginal zones around the augite. These enclosures range from .1 mm. by .1 mm. to .56 mm. by .26 mm. in section. The augite has therefore continued to grow after the now oxidised biotite and the plagioclase have commenced to form. Magnetite dust is also present in a zonary arrangement near the margins.

The proportion of augite present in this type gradually increases from 38.3 per cent. to 66.8 per cent. of the total content.

In the section showing the intruded thread of quartz, augite is associated with the clear plagioclase crystals. It is here perfectly clear malacolite with high refraction and birefringence. One crystal extinguishes at 47 degrees, and in another the cleavage lines make an angle of 85 degrees.

Iron Ores are present in variable quantity, specially associated with the hornblende and augite. In the former the larger idiomorphic crystals appear to be magnetite and the smaller crystals in the augite are ilmenite now changing to leucoxene.

ORDER OF CRYSTALLISATION IN THE BASIC TYPE.

The allotriomorphic character of so many of the minerals indicates that several of them probably ceased to crystallise almost simultaneously but by a comparison of the sections the following is held to be the approximately correct order in which they commenced to form.

1. Ilmenite, magnetite and apatite.
2. Augite and some brown hornblende.
3. Felspar.
   Biotite.
   Brown and greenish hornblende.

SUGGESTED AFFINITIES.

The augite-hornblende diorite, besides resembling many of the "greenstones" found in the Isle of Man, is, from its estimated chemical composition, comparable with some of the augite diorites in Minnesota and the hornblende-augite diorite from Inchnadamf. It probably approaches the composition of a shonkinite chemically. The most basic type would closely resemble the composition of a pyroxenite from Brandberget, Gran, Norway.

3. INTERMEDIATE TYPE.

This type has variable characteristics, but on the whole combines those features which distinguish both the acid and basic types. Specimens arranged in series of decreasing proportions of quartz do not show a corresponding increase of augite and vice versâ, and no specimens have yet been found with both these minerals absent. This variable character suggests that the intermediate facies is a "mixture rock."

Quartz, when it occurs, is very rarely fractured, and is crowded with fluid cavities. There is also an inclusion of an undetermined mineral of prismatic form with blunt pyramidal ends, cross fracture, refractive index apparently less than that of quartz, weak birefringence and doubtful pleochroism in faint blue and yellow. In the basic xenolith previously mentioned the quartz seems to have separated previously coterminous and interlocking crystals, to have torn off minute ragged pieces of the fibrous hornblende and to have partially re-fused the felspar substance towards the boundaries of the fragment.

Felspar. Where quartz is in small quantity or absent, the felspathic mineral is practically allotriomorphic. Elsewhere the forms are usually prismatic, some are sub-idiomorphic and some have still more irregular outlines. The average size is about .6 mm. by .3 mm. It is extremely decomposed so that the genus is quite undeterminable, but the alteration products are quartz, calcite, an epidote or zoisite and amorphous matter. No white mica could be found. Inclusions are very rare.

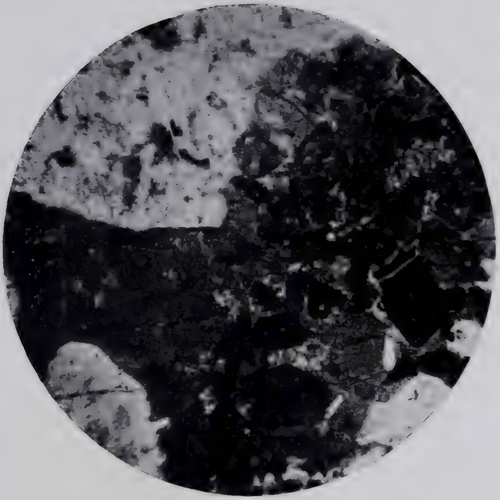


FIG 1.

Oatland Complex. Basic facies. **× 20.**

The allotriomorphic compact brown hornblende encloses felspar crystals and large patches of colourless fibrous hornblende. The opaque mineral is titanomagnetite pseudomorphous after biotite.

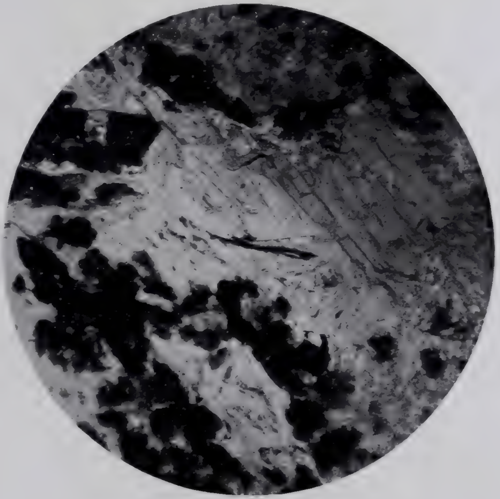


FIG. 2.

Oatland Complex. Basic facies. **× 20.**

The large individuals of colourless fibrous hornblende are now chloritised with separation of much calcite and epidote. A few blades of actinolite are just discernable near the centre of the section. Cloudy, allotriomorphic felspathic matter completes the mineral content.

(Photographed by W. L. Carter.)

Proc. Yorks. Geol. Soc., Vol. XVII., Plate IX.

Biotite is sparingly present to absent in its pale green variety. One less-altered individual of the other variety appears with rather strong pleochroism in two shades of brown, but it is also turbid in places like the more oxidised crystals. The latter are fairly abundant with pleochroism of brown and olive-brown. In addition to the basal cleavage of a mica there is occasionally a poor cleavage not unlike the prismatic cleavage of an amphibole. The following (Figs. 9 to 12) will give an idea of its outline and that of the associated iron ores :—

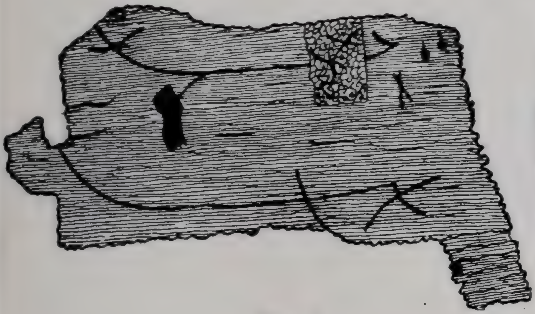


Fig. 9.

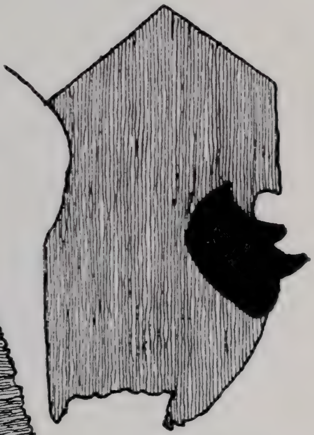


Fig. 10.

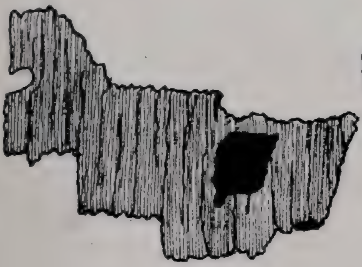


Fig 11

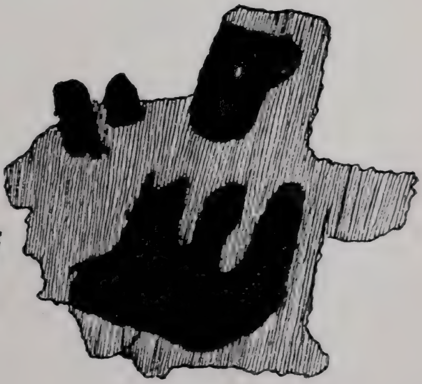


Fig. 12.

The appearance is similar to that of the same species in the more basic acid types of rock. Individuals are sometimes pierced by thorns of quartz like the green biotite in the acid rock. The broad cleavage bands would perhaps evidence a scaly character in the altered mineral like the biotite in the plagioclase-augite rock at Tolcarn, near Penzance, where it has been altered by the granite.

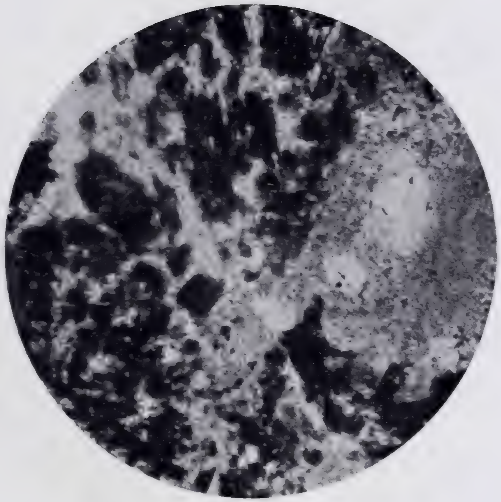
The included iron-ores are not quite opaque at their extreme margins, which show a muddy greenish-brown colour. Where crystals of the biotite have been bleached to a greenish-brown colour the iron-ores are not nearly so plentiful.

Hornblende is found in two varieties, as in the basic rock, but the brown variety is usually tinged with greenish shades, and it occurs in varying quantity with the pale green variety, though the proportion of total amphibole is remarkably constant in all the specimens examined, remaining at 21 per cent. to 23 per cent. The darker variety, with pleochroism = dark green —light green—brownish-straw, often lies embedded in the quartz while the hornblende surrounding the augites is lighter in colour, with pleochroism = bluish-green—brownish-yellow and pale straw.

In the basic xenolith above mentioned the hornblende often occurs as large individuals, sometimes twinned. The extinction angle is about 15 degrees.

Augite has characters like those in the basic rock. One chloritic pseudomorph appears to have a distinct " herring-bone " structure. The outlines are usually regular and hexagonal, and the average dimension is 2.5 mm. by 2.5 mm. There are some colourless patches of unaltered malacolite. The products of alteration are usually uralite, chlorite and calcite, the latter along cleavage planes, and a little iron-ore in minute grains.

In the basic xenolith, particular crystals of augite show interesting features. One individual 2.6 mm. by 1.82 mm. has within the outer zone of chlorite a patch of uralite about 1.45 mm. by 1.45 mm., surrounded by a narrow zone of magnetite dust and hornblende with a pleochroism = brownish-green—light-green-straw. In the heart of the crystal is a patch of unaltered



Oatland Complex. Extreme Basic Facies. × *20.*

The uralic augite crystal is seen enclosing small patches of pale fibrous hornblende. Compact hornblende almost surrounds the augite. Dusty felspathic matter occasionally with the outlines of plagioclase lies embedded in the pale green chloritised hornblende. An individual of oxidised biotite is by the circumference remote from the augite.

(Photographed by W. L. Carter.)

malacolite about .5 mm. by .5 mm., with strong D. Refraction. Similar phenomena belong to another crystal measuring 2.4 mm. by 2.3 mm. A still larger crystal, 2.9 mm. by 2.5 mm., shows multiple twinning like the augites in the rock at Poortown, but more hornblende appears to have been originally included and more iron-ores have been liberated. Quartz has penetrated the crystal in several directions.

A few general observations may here be made respecting this sub-angular basic xenolith. Near the margins of the fragment the minerals are arranged—like the whole of the xenolith found in the heart of the boss—as a confused aggregate of minute crystals crowded with amphibole, while the felspars of the surrounding granodiorite lie tangentially to the outline of the knob. The acid portion of the slide shows an abnormal quantity of the darker oxidised biotite, and, to a less degree, of plagioclase. It appears as though the matrix of amphibole had been dissolved from the surface of the xenolith leaving the biotite and felspar and a little augite free in the solute. Near the included fragments the hornblende has recrystallised in good idiomorphic forms unlike its usual habit elsewhere in the boss.

ORDER OF CRYSTALLISATION IN THE INTERMEDIATE TYPE.

Similar considerations affect the determination of this as are noted in connection with the basic type.

APPARENT ORDER.

1. Apatite, ilmenite and magnetite.
2. Augite, and, in places, a little hornblende.
3. Felspar
4. Br. Biotite

or

3. Br. Biotite
4. Felspar.

in the more acid facies of the type.

5. Compact hornblende.
6. Fibrous hornblende.
7. Quartz, when present.

SUGGESTED AFFINITIES.

The intermediate type may be described as an augite-hornblende-biotite-diorite. Mineralogically it resembles the rock from Seathwaite How (Teall, Brit. Petr., p. 276). The calculated chemical composition closely agrees with that of the diorite from Netherley, Strathspey, also with the diorite from Benn au Thurian, except that in the latter the ratio between potash and soda is inverse.

THE ROCK AT BALLABUNT.

Two sections from this small intrusion were examined and the results showed that the rock presents close correspondences with that at Oatland, which occurs only two miles to the S.S.W., in a direction parallel to the structural axis of the island.

Quartz has the granitic habit, as at Oatland, and is crowded with fluid cavities.

Felspars have also the habit of those in the more acid rock at Oatland. They are extremely decomposed, apparently to white mica, and cases of twinning can rarely be detected. A few forms gave extinction angles of about 13 degrees.

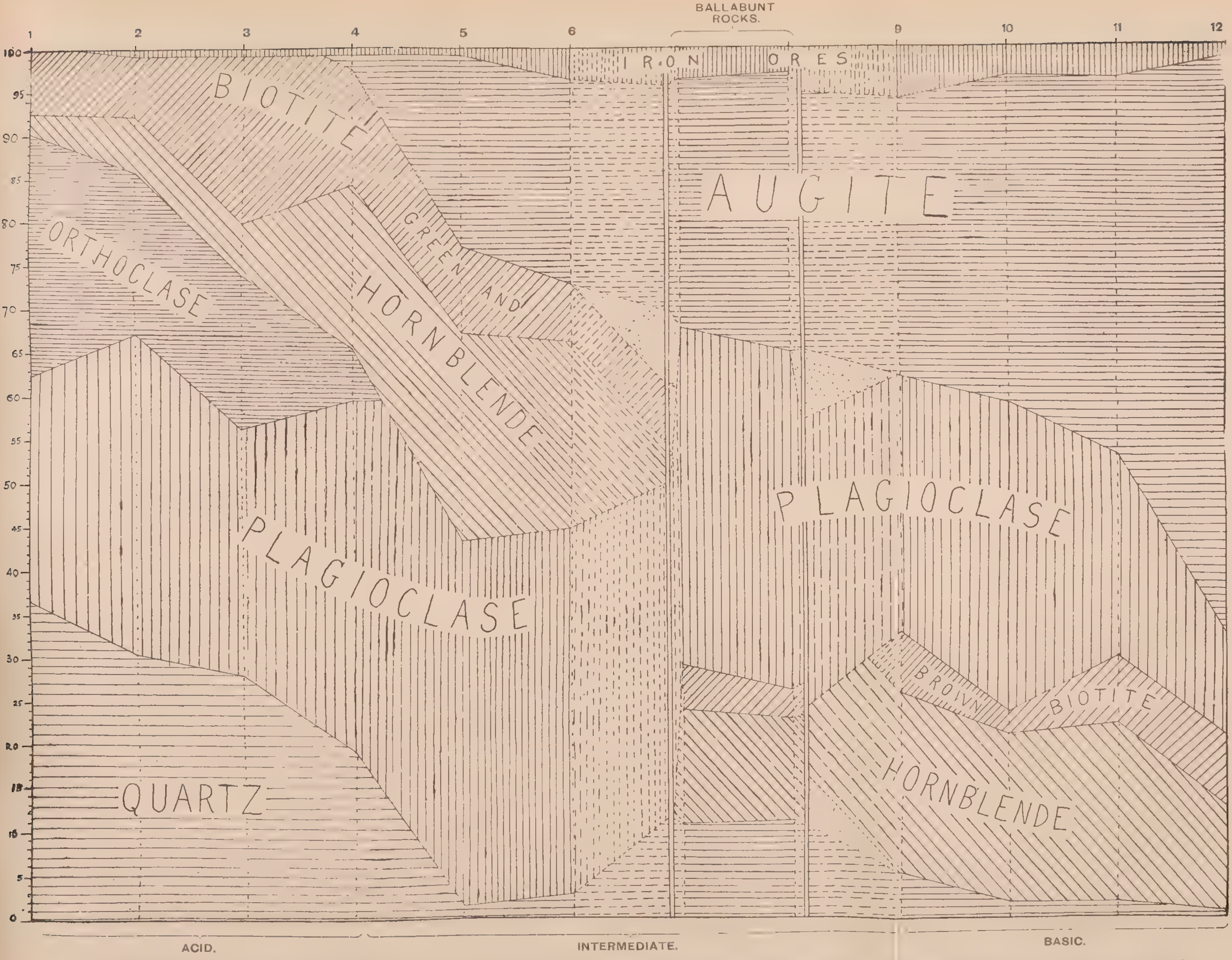
Biotite of green colour in pseudomorphs of chlorite enclose octahedra and irregular grains of titanomagnetite together with a few veins of epidote.

Augite occurs in some quantity, now uralitised and of a very pale green colour. It is almost always twinned. Some subidiomorphic green hornblende and tangles of actinolite, the blades of which often cross at angles of 84 degrees, occur in the interior of the crystals. The refraction of the actinolite is less than that of the surrounding hornblende. Some apatite is included.

Hornblende of a dark green colour occurs on the borders of the augite and usually, but not always, optically continuous with it. A little compact green hornblende also occurs apparently not connected with the augite but frequently moulded on the biotite. The crystals are usually more compact than those at Oatland.

Iron Ores. Ilmenite is the most abundant but scales of haematite occur in the augite and the green hornblende.

GRAPHIC REPRESENTATION OF THE MINERAL CONTENT OF THE ROCKS



In this diagram the length of the intercept of any mineral on the vertical line will give the percentage of that mineral in a given rock section. Twelve sections were measured, numbers 1 to 6 and 9 to 12 being from the Oatland complex, and numbers 7 and 8 from the Ballabunt Rock.

In each case also the order in which the minerals are placed, reading from top to bottom, will give the order in which they successively crystallised in bulk.

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The order of crystallisation of the minerals was the same in both slides, viz. :—

1. Apatite and iron ores.
2. Augite.
3. Felspar.
4. Biotite.
5. Hornblende.
6. Quartz.

The gravimetric mineralogical composition of the two sections proved to be

	1.	2.
Quartz	10.03 ..	10.09
Felspar	37.95 ..	39.49
Augite	29.99 ..	32.57
Hornblende ..	14.70 ..	12.34
Biotite	4.53 ..	2.88
Iron Ores	2.80 ..	2.63

SUGGESTED HISTORY OF THE INTRUSION.

Following the great E. and W. earth pressure, which caused the complex folding in the island, came the intrusion of an igneous rock magma, probably already highly differentiated, as a sill of basic rock.

Afterwards, and the petrological evidence on the whole points to the lapse of a considerable period, came a second intrusion from the same magma reservoir, probably laccolitic in habit, which lifted the overlying rocks and by intimate mixture with the already consolidated basic rock formed at the plane of junction a hybrid or " mixture " rock while the acid magma penetrated the surrounding crust of basic rock in innumerable tongues, veins and *Fasern.*

The last effort of the igneous intrusion to reach the surface resulted in the injection of the remaining super-heated silica-magma as a quartz dyke (similar to those at Foxdale, described by Lomas) which dissolved some of the last crystallised and fibrous amphibole and altered the basic rock at its conterminous parts into a fresh-looking augite-diorite.

ON THE FOSSIL FLORA OF THE SOUTHERN PORTION OF THE YORKSHIRE COALFIELD IN NORTH DERBYSHIRE AND NOTTINGHAMSHIRE.

BY E. A. NEWELL ARBER, M.A., F.L.S., F.G.S.,
Trinity College, Cambridge, University Demonstrator in Palæobotany.

(Plates XII.-XIX.)

(*Read November 3rd*, 1910.)

The systematic palæobotanical exploration of the great Yorkshire Coalfield has now been in progress for a considerable number of years. The plant petrifactions, found in the "Coal Balls" of the Gannister or Halifax Hard Seam of the Lower Coal Measures of Yorkshire, have been described by Binney, Williamson, Scott and others. Dr. Kidston has been occupied for twenty years past with a study of the plant impressions, chiefly of the Middle Coal Measures, especially those from the central portion of the Yorkshire basin, and has published two papers,[1] and six reports[2] on the flora of these rocks. The plant remains from the Southern extension of the Yorkshire Coalfield in North Derbyshire and Nottinghamshire have hitherto received little attention, and it is with this district that the present paper is concerned.

PREVIOUS RECORDS.

The earliest figures of fossil-plants from this portion of the Yorkshire Coalfield are to be found in Martin's *Petrificata Derbiensia*, published in 1809. Among the specimens there figured are examples from Chesterfield, Alfreton and elsewhere, of *Alethopteris lonchitica* (Schloth.) [=*Phytolithus filicites* (*striatus*), plate 10]; *Stigmaria ficoides*, Sternb. [=*Phytolithus plantites* (*verrucosus*), plates 11, 12]; and species of *Neuropteris* [plate 19],

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[1] Kidston (96).

[2] Kidston (90).

Annularia [plate 20], *Trigonocarpus* [plate 21], *Calamites* [plates 25, 26], and *Lepidodendron* [plate 50]. Several of the specimens figured were contained in ironstone nodules. No detailed information is, however, given as to the precise locality, seam or horizon.

In 1903, Mr. Wedd[1] recorded *Neuropteris* sp., and *Lepidodendron* sp. from the Black Shale Coal at Denby Colliery, and *Calamites* sp. from the same coal at Heage Colliery.

In 1907, Mr. Horwood[2] of Leicester, published a short paper, in which he gives a list of all the specimens known from this coalfield with a bibliography. He records the following plants, whose exact position in the Coal Measures has been ascertained, some of which he figures.

(1) FROM THE TOP HARD COAL AT PLEASLEY COLLIERY.

Sphenopteris obtusiloba, Brongn.
S. artemisiæfolioides, Crépin.
Dactylotheca plumosa (Artis).
Mariopteris muricata (Schloth.).
Alethopteris lonchitica (Schloth.).
Odontopteris sp.
Neuropteris heterophylla, Brongn.
N. tenuifolia, Schloth.
N. gigantea, Sternb.
N. sp.
Calamites sp.
Calamocladus equisetiformis (Schloth.).
Annularia galioides (L. and H.).
A. radiata, Brongn.
Lepidodendron ophiurus, Brongn.
L. obovatum, Sternb.
L. sp.
Lepidostrobus ophiurus, Brongn.
Lepidostrobus variabilis, L. and H.
Lepidophyllum majus, Brongn.
Sigillaria mamillaris, Brongn.

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[1] Wedd (03), p. 12.

[2] Horwood (07).

S. cf. tenuis, Achep.
Stigmaria ficoides (Sternb.).
Carpolithes wildii, Kidst.
Trigonocarpus parkinsoni, Brongn.
Rhabdocarpus sp.

(2) From the Tupton Main Seam at Hardwicke Pit.

Neuropteris heterophylla, Brongn.
N. gigantea, Sternb.
N. impar, Weiss M.S.

In the recently published Survey Memoir on the district, Dr. Walcot Gibson[1] records the following species from the Lower Coal Measures :—

Calamities cf. C. schutzei Stur.	Wingfield Flagstones.
Sphenophyllum cuneifolium, Sternb.	Above Alton Coal.
Lepidodendron lycopodioides, Sternb.	Belperlawn Coal and Wingfield Flagstones and above Alton Coal, etc.

while other genera are mentioned.

During last year, my friend and pupil, Mr. R. D. Vernon,[2] B.Sc., published an interesting geological and general account of the Lower Coal Measures of the area under consideration here. He recorded *Calamites cf. C. varians* Sternb., *Cordaites* sp., and *Crossotheca* sp., from the Wingfield Flagstones below the Kilburn Coal, passed through in the Ruddington Boring, and he also mentions *Calamites cf. C. schutzei* Stur., *Sphenophyllum cuneifolium* Sternb., *Lepidodendron aculeatum* Sternb., *L. lycopodioides* Sternb., *Lepidophloios* sp., *Lepidostrobus* sp., *Sigillaria* sp., and *Stigmaria ficoides* Sternb., as occurring in the Lower Coal Measures of the district.

Specimens from this portion of the Yorkshire coalfield have also been incidentally discussed on previous occasions by various writers, and examples are to be found in some of the larger collections of fossil plants in this country, especially those from

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[1] Gibson (08) pp. 100, 183, 185, 186.
[2] Vernon (09) pp. 293, 296.

Clay Cross, presented by Dr. Pegler to the British Museum (Nat. Hist.) in 1892. Mr. Horwood[1] gives a list of these fossils. In these cases, however, the exact origin or horizon of the plants is unknown, though the Clay Cross fossils are for the most part from the Middle Coal Measures.

THE FOSSIL FLORA.

My friend, Dr. L. Moysey, F.G.S., of Nottingham, has for some years past devoted much attention to the palæontology of that portion of the basin, which lies to the West and North-west of that town. He has obtained a large collection, chiefly derived from the clay-ironstone nodules, both of invertebrates and of fish and plant remains. The former are in course of description by Dr. Henry Woodward. Dr. Moysey has generously placed the fine series of fossil plants in his collection at my disposal for examination and description. For his kindness in this matter I owe him many thanks, and I am also indebted to him for opportunities of visiting the chief localities, from which his collection has been derived. It should be also pointed out here that the excellence of many of the specimens in Dr. Moysey's collection is due to his ingenious method of splitting the ironstone nodules in natural planes, by the freezing method, which he has described in a paper published in 1908.[2]

The southern extension of the Yorkshire Coalfield lies partly in North Derbyshire and partly in Nottinghamshire, the boundary between the counties being the river Erewash, which traverses the strike of the most southern portion of the field. Thus two localities, though only separated by a few hundred yards, may be in two different counties.

The succession of coal seams in this district is given by Dr. Walcot Gibson,[3] in the recently published Survey Memoir, where a full account of the geology will be found. The majority of Dr. Moysey's specimens were derived from clay pits, the horizons of which may be regarded as approximately identical with that of the Top Hard Coal. A smaller number of specimens have also been obtained from between the Waterloo and the Ell and Deep

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[1] Horwood (07). [2] Moysey (08). [3] Gibson (08).

Soft Coals at Newthorpe, and at Pye Bridge Railway cutting; from below the Silkstone Coal at Derby; from the horizon of the Kilburn Coal at Trowell and Stanley Collieries, and from below that horizon at Albany.

THE MIDDLE COAL MEASURE FLORA.

The Top Hard Coal of the Derbyshire and Nottingham portion of the Coalfield has been identified by Dr. Walcot Gibson[1] with the Barnsley Thick Coal of Yorkshire. It may, therefore, be interesting to compare the known floras of these two seams—as a study of the lateral distribution of plants belonging to exactly the same seam over an area of considerable extent. The following table affords such a comparison. It includes all the plants recorded by Dr. Kidston from the Barnsley seam in his six reports on the flora of the Yorkshire Coalfield.[2] The flora of the Derbyshire and Nottingham Top Hard Coal, at least 40 miles south of Barnsley, is shown in the left hand column. The letters there used indicate the exact origin of the specimens in the latter coalfield, which are as follows :—

L = Loscoe Clay Pit, Heanor, Derby ; just above the Top Hard Coal.

D = Digby Clay Pit, Kimberley, Notts. ; just above the Top Hard Coal.

B = Brindsley Clay Pit, Langley Mills, Notts. ; just above the Top Hard Coal.

W = Waingrove Clay Pit, nr. Cross Hills Station, Derby ; below Top Hard Coal.

S = Shipley Clay Pit, Derby ; below Top Hard Coal.

C = Wollaton Canal Clay Pit, Notts. ; below Top Hard Coal

All the specimens are from "rakes," or clay ironstone nodules, occurring a short distance either above, or below, the Top Hard Coal.

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[1] Gibson (98) pp. 5—7.

[2] Kidston (90).

NAME.	Horizon of the Top Hard Coal, Nottinghamshire.	Horizon of the Barnsley Thick Coal, Yorkshire.
EQUISETALES.		
Calamites britannicus, Weiss	..	X.
Calamites suckowi, Brongn.	D.	X.
Calamites cisti, Brongn.	L., S., C.	X.
Calamites undulatus, Sternb.	D.	X.
Calamites varians, Sternb.	C.	X.
Calamites ramosus, Artis	C.	X.
Calamites schatzlarensis, Stur	..	X.
Calamites cruciatus (Sternb.)	B.	..
Calamitina verticillata, L. & H.	..	X.
Equisitites hemingwayi, Kidst.	S.	X.
Calamocladus equisetiformis (Schloth.)	S.	X.
C. Longifolius (Sternb.)	S.	X.
C. charæformis (Sternb.)	S., B.	X.
Annularia radiata, Brongn.	S.	..
A. galioides (L. & H.)	S., D.	..
Calamostachys cf. longifolia, Weiss	..	X.
C. germanica, Weiss	S.	..
Calamostachys sp.	D., S.	..
Stachannularia ? northumbriana, Kidst.	..	X.
Palæostachya gracillima, Weiss	B.	X.
P. elongata, Presl.	..	X.
P. pedunculata, Will.	..	X.
P. ettingshauseni, Kidst.	..	X.
Macrostachya sp.	..	X.
Pinnularia prostrata, Artis	..	X.
P. sp.	D., S., B.	..
SPHENOPHYLLALES.		
Sphenophyllum majus, Brongn.	S.	X.
S. cuneifolium (Sternb.)	S.	X.
,, ,, var. *saxifragæfolium* (Sternb.)	..	X.
S. cf. oblongifolium, Germ.	..	X.
S. myriophyllum, Crépin	..	X.
S. trichomatosum, Stur	..	X.

Kidston (03) p. 794.

NAME	Horizon of the Top Hard Coal, Nottinghamshire.	Horizon of the Barnsley Thick Coal, Yorkshire.
PTERIDOSPERMS AND PRIMOFILICES.		
Neuropteris heterophylla, Brongn.	L., D., S.	X.
N. gigantea, Sternb.	S.	X.
N. grangeri, Brongn.	..	X.
N. obliqua, Brongn.	S.	X.
N. rarinervis, Bunb.	? D., S.	X.
N. Osmundæ, (Artis)	S.	X.
N. acuminata, (Schloth.)	S.	..
N. tenuifolia, (Schloth.)	S.	X.
Cyclopteris trichomanoides, Sternb.	D., S.	..
Alethopteris lonchitica (Schloth.)	D., S.	X.
A. decurrens (Artis)	D.	X.
A. valida, Boul.	..	X.
A. davreuxsi, Brongn.	D., S.	X.
Sphenopteris rotundifolia, Andræ	..	X.
Spenopteris marattii, Kidst.	..	X.
Sphenopteris obtusiloba, Brongn.	S.	X.
S. trifoliata (Artis)	..	X.
S. furcata, Brongn.	S.	X.
S. laurenti, Andræ	..	X.
S. crenata, L. & H.	..	X.
S. acuta, Brongn.	..	X.
S. spiniformis, Kidst.	..	X.
S. sternbergi, Ett.	..	X.
S. jacquoti, Zeill.	..	X.
S. dilatata, L. & H.	B.	X.
S. zobeli (Gœpp.)	..	X.
S. (*Corynepteris*) *coralloides*, Gutbier	S.	..
Renaultia gracilis (Brongn.)	D.	..
R. schatzlarensis (Stur)	..	X.
R. footneri (Marrat)	..	X.
Zeilleria alvoldensis (Stur)	S.	..
Z. delicatula (Sternb.)	..	X.
Urnatopteris tenella (Brongn.)	D., S.	..
Oligocarpia brongniarti, Stur	S.	X.
Eremopteris moyseyi, n. sp.	D.	..
Crossotheca schatzlarensis (Stur)	..	X.
Crossotheca, sp.	? S.	..
Pecopteris miltoni (Artis)	S.	X.
P. volkmanni, Sauveur	..	X.
Dactylotheca plumosa (Artis)	..	X.
Mariopteris muricata (Schloth.)	B., D., S.	X.
,, *latifolia* (Brongn.)	B., ? S.	X.
Odontopteris britannica, Gutb.	..	X.
,, *binervosa*, Achepol	..	X.
O. sp.	..	X.
Rhacophyllum crispum (Gutb.)	..	X.
,, var. *lineale* (Gutb)	S.	X.
Megaphyton anomalum, Grand'Eury	..	X.
,, *frondosum*, Art.	..	X.

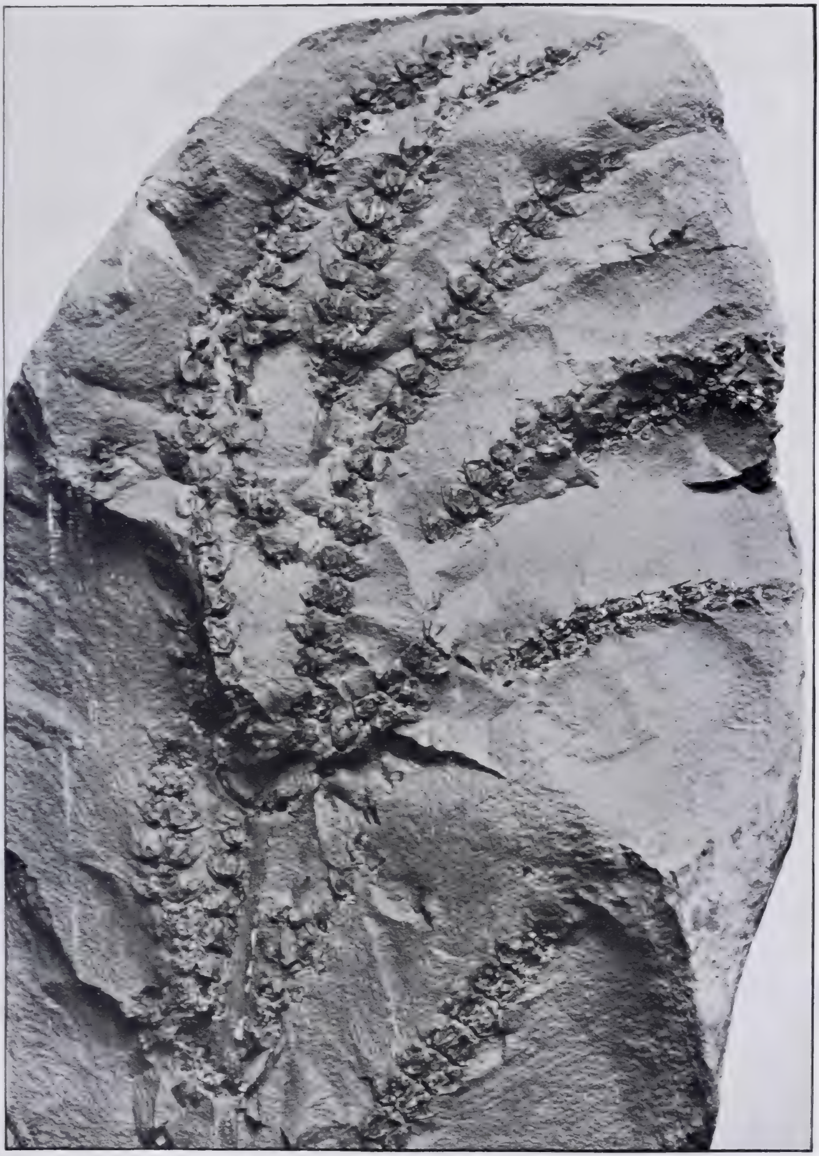
NAME.	Horizon of the Top Hard Coal, Nottinghamshire.	Horizon of the Barnsley Thick Coal, Yorkshire.
Semina.		
Trigonocarpus parkinsoni, Brongn.	S.	X.
,, forma *bockschianus* (G. & B.)	..	X.
,, ,, *amygdalæformis* (G. & B.)	..	X.
Rhabdocarpus elongatus, Kidst.	..	X.
R. sp.	S.	..
Cardiocarpus subacutus, Grand'Eury	..	X.
C. fluitans, Dawson	..	X.
Polypterocarpus, sp.	..	X.
Carpolithes bivalvis, Goepp.	..	X.
C. inflatus, Lesq.	..	X.
Gnetopsis sp.	..	X.
Lycopodiales.		
Lepidodendron lycopodioides, Sternb.	B.,L.,D.,S.	X.
L. wortheni, Lesq.	S.	X.
L. obovatum, Sternb.	L.	X.
L. ophiurus, Brongn.	? S.	X.
L. aculeatum, Sternb.	..	X.
L. rimosum, Sternb.	..	X.
L. haidingeri, Ett.	..	X.
Asolanus camptotænia, Wood	S.	X.
Sigillaria tenuis, Arch.	..	X.
S. polyploca, Boul.	..	X.
S. saulii, Brongn.	..	X.
S. reniformis, Brongn.	..	X.
S. ? boblayi, Brongn.	..	X.
S. ovata, Sauveur	..	X.
S. deutschi, Brongn.	..	X.
S. tessellata (Sternb.)	..	X.
S. elegans, Brongn.	..	X.
S. discophora (König)	..	X.
S. mamillaris, Brongn.	..	X.
S. scutellata, Brongn.	..	X.
S. lævigata, Brongn.	..	X.
S. rugosa, Brongn.	..	X.
S. elongata, Brongn.	..	X.
S. sol, Kidst.	..	X.
S. sp.	S.	..
Bothrodendron minutifolium (Boul.)	S.	X.
Lepidophloios acerosus, L. & H.	..	X.
Lepidophyllum majus, Brongn.	D., S.	X.
Lepidophyllum, sp.	D., S.	..
Lepidostrobus triangulare, Zeiller	S.	X.
L. lanceolatus (L. & H.)	? B.	X.
L. anthemis (König)	..	X.
L. sp.	D., S., B.	..

NAME.	Horizon of the Top Hard Coal, Nottinghamshire.	Horizon of the Barnsley Thick Coal, Yorkshire
Sigillariostrobus rhombibracteatus, Kidst.	..	X.
,, *ciliatus*, Kidst.	..	X.
Sigillariostrobus, sp.	D.	..
Stigmaria ficoides (Sternb.)	S., etc.	X.
S. reticulata, Gœpp.	..	X.
CORDAITALES.		
Cordaites borassifolius (Sternb.)	W.	..
C. principalis (Germ.)	S.	X.
Artisia transversa (Artis)	..	X.
Cordaianthus pitcarniæ (L. & H.)	W.	X.
C. volkmanni (Ett.)	..	X.
C. sp.	S.	..

Comparing the two floras, from localities at least forty miles apart, we find that they are remarkably alike. The Yorkshire records are the richer, especially in species of *Calamites*, *Sphenophyllum*, *Sphenopteris*, *Odontopteris* and particularly *Sigillaria*. It must, however, be remembered that Dr. Moysey's specimens were obtained from clay-ironstone nodules exclusively, whereas the plants known from Yorkshire were found in all types of lithological sediments.

The following Nottinghamshire and Derbyshire species have not been obtained from the Barnsley Thick Coal in Yorkshire, though many of them occur on other horizons :—

Calamites cf. C. gœpperti (Ett.).
C. cruciatus, Sternb.
Annularia radiata, Brongn.
A. galioides, L. & H.
Neuropteris acuminata (Schloth.).
Zeilleria alvoldensis (Stur).
Renaultia gracilis (Brongn.).
Urnatopteris tenella (Brongn.).
Eremopteris moyseyi n. sp.
Corynepteris coralloides, Gutbier.
Cordaites borassifolius (Sternb.).



E. A. N. Arber, Photo. André & Sleigh, Ltd.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XII.

Dr. Moysey has also collected the following specimens from the Middle Coal Measures, below the horizon of the Top Hard Coal.

From Newthorpe Clay Pit, No. 1 (Nottinghamshire), between the Waterloo and the Ell and Deep soft coals :—

Calamites approximatus, Brongn.
C. undulatus (Sternb.).
Calamites, sp.
Sphenopteris (*Corynepteris*) *coralloides*, Gutbier.
Sphenopteris sp.
Neuropteris heterophylla, Brongn.
Mariopteris muricata (Schloth.).
Cordaites principalis (Germ.).
Doricordaites palmæformis (Gœpp.).

From the Pyebridge Railway cutting, Nottinghamshire, a little above the Ell coal :—

Calamites cf. C. cisti, Brongn.
Alethopteris lonchitica (Schloth.).
Neuropteris, sp.
Lepidodendron obovatum, Sternb.

From the Denby Clay Pit, Derby, between the Silkstone and the Mickley Coals :—

Mariopteris muricata (Schloth.).
Lepidodendron aculeatum (Sternb.).

All these plants, except *Sphenopteris* (*Corynepteris*) *coralloides*, Gutbier, have been previously recorded from the Middle Coal Measures of the central portion of the Yorkshire Coalfield.

THE LOWER COAL MEASURE FLORA.

The series of sediments beginning with the Belperlawn Coal, above the First Grit, to the Kilburn Coal, about 800 feet in thickness, and including also the Alton and some other thin seams, are regarded by Walcot Gibson[1] and Vernon[2] as Lower Coal Measures.

The Kilburn Coal thins to the northward, and in the central district of the field, in Yorkshire, it is absent, though it reappears again in the Huddersfield district, as the Better Bed Coal.

---

[1] Walcot Gibson (08).

[2] Vernon (09).

The Alton and Belperlawn Coals persist into the central district, where the former is known as the Gannister or Halifax Hard Coal ; a seam of special interest to Palæobotanists, on account of the calcareous nodules containing plant petrifactions, which are associated with this seam, near Halifax.

The following species were obtained from the horizon of the Kilburn Coal at Trowell, T, (Nottinghamshire) and Stanley, S, (Derby) Collieries, by Dr. Moysey :—

NAME.	N. Derby and Nottinghamshire.	* Yorkshire.
EQUISETALES.		
Calamites cisti, Brongn.	T.	..
C. varians, Sternb.	T.	..
C. sp.	T.	..
SPHENOPHYLLALES.		
Sphenophyllum sp.	T.	..
PTERIDOSPERMEÆ and PRIMOFILICES.		
Neuropteris osmundæ, (Artis)	T.	..
N. obliqua, Brongn.	T. & S.	..
N. heterophylla, Brongn.	T.	M. G.
N. (*Cyclopteris*) sp.	T.	..
Alethopteris lonchitica, (Scholth.)	T.	M. G.
Mariopteris muricata, (Scholth.)	T.	M. G.
Pecopteris miltoni, (Artis)	S.	..
Rhacophyllum sp.	T.	..
Rhabdocarpus elongatus, Kidst.	T.	..
LYCOPODIALES.		
Lepidodendron lycopodioides, Sternb.	T.	X.
Sigillaria discophora, (König)	T.	X. + M. G.
Lepidophyllum sp.	T.	..
Lepidostrobus sp.	T.	..
CORDAITALES.		
Artisia approximata, (Brongn.)	T.	M. G.

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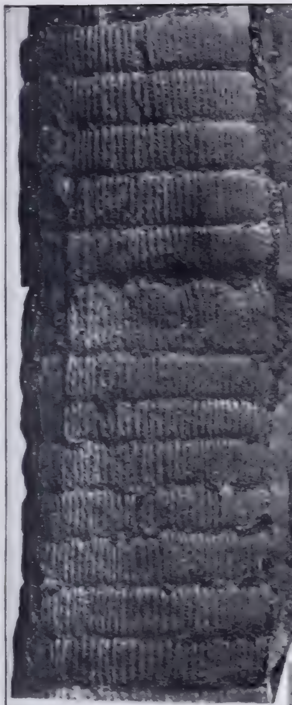
* In this column, the "X" indicates that the species has been recorded by Dr. Kidston from the Lower Coal Measures, and "M.G.," from the Millstone Grit of the Central district in Yorkshire.



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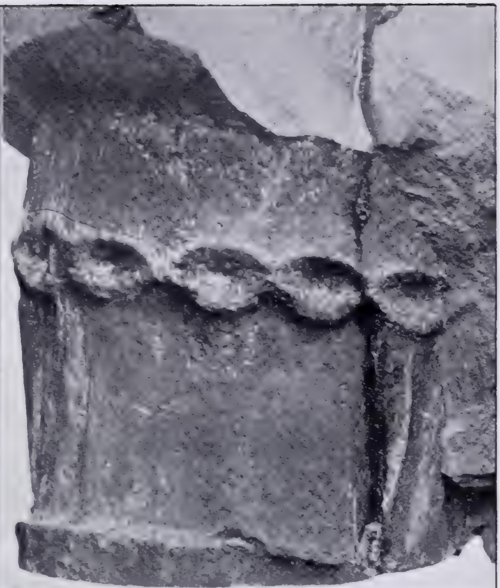

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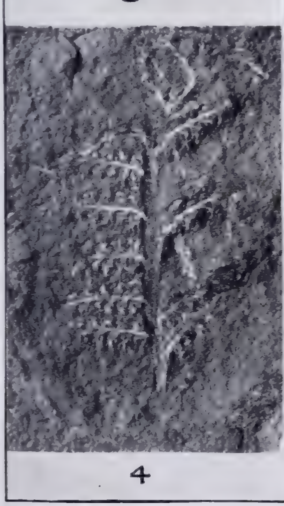

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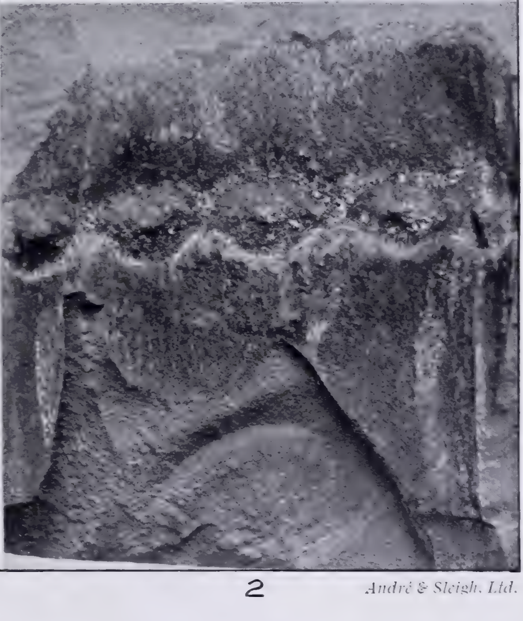

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E. A. N. Arber, Photo. André & Sleigh, Ltd.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XIII.

From the Old Albany clay pit, at some little distance below the Kilburn Coal, specimens of *Calamites Suckowi* Brongn. were obtained. *Calamites cisti* Brongn. and *C. varians* Sternb., *P. miltoni* (Artis), *Rhabdocarpus elongatus* Kidst., are known from the Lower Coal Measures of other coalfields, though *Pecopteris miltoni* is very rare on this horizon. On the other hand, *Neuropteris osmundæ* (Artis) and *N. obliqua* Brongn. have not hitherto been found, so far as I am aware, below the Middle Coal Measures, on which horizon they also occur in Derbyshire and Nottinghamshire.

NOTES ON SOME OF THE FIGURED SPECIMENS.

A selection of typical fossils from Dr. Moysey's collection is figured on Plates XII.-XIX. Several of these are well known plants in other coalfields, and do not call for remark here. Other specimens, however, are rarer, or particularly well preserved, and in these cases the following notes may perhaps be of service, in addition to references to further figures of the fossils themselves.

Palæostachya gracillima, Weiss.

Plate XII.

1884. *Palæostachya gracillima*, Weiss, Abhandl. Geol. Specialk. Preuss., Vol. V., Part II., p. 184, Plate XVIII., Fig. 1.

1886. *?Palæostachya gracillima*, Kidston, Trans. Geol. Soc., Glasgow, Vol. VIII., p. 54, Plate III., Fig. 3.

1890. *Palæostachya gracillima*, Kidston, 1st Report York. Carb. Flora, Trans. Yorks. Nat. Union, No. 14, p. 24.

It may be doubted if a more complete specimen of this fructiferous branch of a Calamite than that figured on Plate XII. has ever been found. The cones are, for the most part, still in continuity with the slender axis, which bore them. They were borne in whorls, of which four are seen in the photograph. Four or more cones appear to have been attached to each node. The cones measured about 6 cm. in length, and they were apparently sessile. The bracts are small and short. The sporophylls and sporangia can be clearly seen, the former arising in the axils of the bract. Weiss appears to have been somewhat doubtful as to the attachment of the sporophylls in the type specimen, but this feature is clearly seen in the present example.

Calamites sp.

Plate XIII., Figs. 1 and 2.

The external surfaces of Calamite stems are much rarer fossils than the pith-casts. The cast and impression of the external surface of a specimen, from the Lower Coal Measures of Trowell Colliery, which is figured on Plate II., Figs. 1 and 2, shows two nodes, one of which bears five large, oval, branch-scars. The internodes are smooth, and not ribbed as in the case of the pith-casts. In this specimen the internodes are probably of unequal length, though this cannot be ascertained with certainty. From the British Carboniferous rocks, apparently only three species of Calamites are at all well known by their external surfaces. Two of these, *C. britannicus* Weiss and *C. ramosus* Artis, belong to the section Eucalamites, which possess branch scars on every node. The third, *Calamites gœpperti* (Ett.), which is probably the external surface of the plant, whose pith cast is known as *C. varians* Sternb., belongs to the Calamitina section. The present specimen has similar affinities. It differs from *C. gœpperti*, however, in the oval form of the branch-scars, the longer axis of which is transverse or horizontal. In *C. gœpperti*, the branch-scars are more nearly square or oblong in form, and somewhat larger in size. The specimen, while apparently distinct from any hitherto described, is not sufficiently perfect to serve as the type of a new species, and for the present it is best described as *Calamites* sp.

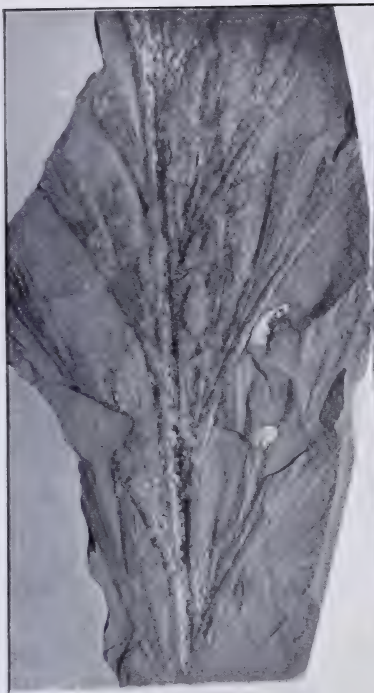
Calamites approximatus, Brongniart.

Plate XIII., Fig. 3.

1828. *Calamites approximatus*, Brongniart, Hist. Végét. Foss., p. 133, Plate XXIV., Figs. 2-5.

1855. *Calamites approximatus*, Geinitz, Vers. Steinkohlenf. Sachsen, p. 7, Plate XII., Fig. 3.

1884. *Calamites approximatus*, Weiss, Abhandl. Geol. Specialk. Preuss., Vol. V., Part 2, p. 81, Plate XXV., Fig. 1.



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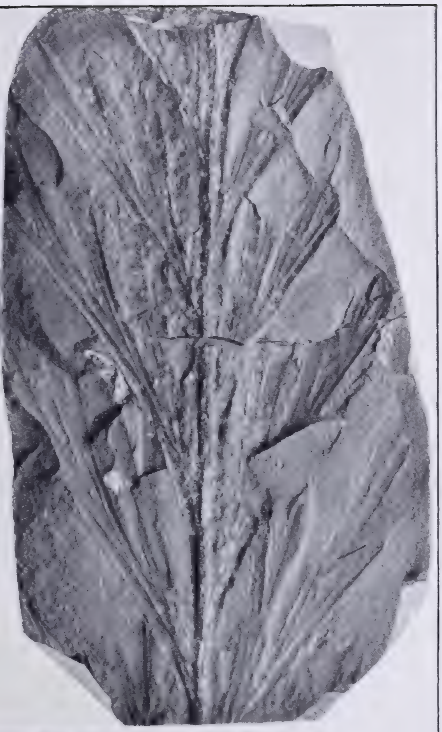

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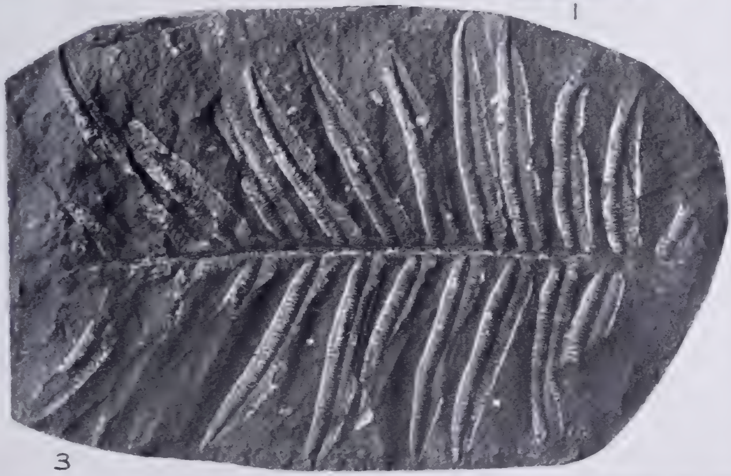

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E. A. N. Arber, Photo.

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Proc. Yorks. Geol. Soc., Vol. XVII., Plate XIV.

1893. *Calamites approximatus*, Kidston, Trans. Roy. Soc., Edinb., Vol. XXXVII., p. 311, Plate II., Fig. 5-6.

1898. *Calamites* (*Calamitina*) *approximatus*, Seward, Foss. Plants, Vol. I., p. 369, Fig. 100.

1901. *Calamites approximatus*, Kidston, Proc. Yorkshire Geol. and Polytech. Soc., Vol. XIV., Plate XXXV., Fig. 2.

1903. *Calamites approximatus*, Arber, Quart. Journ. Geol. Soc., Vol. LIX., p. 5, Plate I., Fig. 3.

The Calamite pith-cast, figured on Plate XIII., Fig. 3, possessing very short internodes, with which somewhat longer internodes bearing a ring of branch scars, occasionally alternate, is a fairly frequent fossil in the British Coal Measures. At the present time, there appears to be some difficulty as to the name which should be applied to this plant. The name *Calamites approximatus*[3] was first instituted by Schlotheim[1], who did not, however, figure an example. It has been pointed out by Zeiller and Kidston that pith-casts, such as those since figured by Brongniart and others (see above) under this name, do not agree with Schlotheim's description of his plant, whatever it may have been. Kidston[2] has proposed that Stur's name *Calamites waldenburgensis*[3] should be applied to such fossils as those here figured ; though it seems probable that two species of pith-cast were included by Stur under this name. On the other hand, it appears to me preferable to maintain the name *C. approximatus*, which has become established, and this can be easily done by ignoring Schlotheim's diagnosis which was imperfect, because it was not illustrated by a figure, and taking the specimens described and figured by Brongniart, as the types of *Calamites approximatus*.

Eremopteris moyseyi, sp. nova.

Plate XIV., Figs. 1 and 2.

A single specimen, in a nodule from the Middle Coal Measures of Digby Clay Pit, Kimberley (Nottinghamshire), on the horizon of the Top Hard Coal, was collected by Dr. Moysey, which appears to me to be a new species of fern-like frond, referable to the genus

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[1] Schlotheim, Petrifactenkunde, p. 399, 1820.
[2] Kidston, Trans. Roy. Soc. Edinburgh, Vol. XL. p. 789, 1903.
[3] Stur, Steinkohl. Calamarien, Pt. II., Pl. XXV., Fig. 1, 1887.

Eremopteris of Schimper. The two halves of this nodule are seen on Plate XIV., Figs. 1 and 2. The frond was compound, with long, wedge-shaped, divided, alternate pinnules, each segment traversed by a single nerve, which forks below the next division of the leaf. This frond differs specifically from *E. artemisiæfolia*, Sternb., the best known member of the genus in Britain, in the size and shape of the pinnules. I have not been able to identify it with any other species of this little known, and somewhat rare genus, with which I am acquainted.

The following is a diagnosis of the new species :—Frond compound. Rachis of ultimate pinnæ grooved. Pinnules alternate, large, semi-erect, more than 4 cm. in length, unsymmetrically wedge-shaped, deeply divided or segmented, divisions long, cuneiform-linear, broadest at the apex. Nervation simple, dichotomous. A single nerve enters the base of the pinnule, where it quickly dichotomises, giving a nerve to each segment, which in turn forks a little below the next higher division of the segment.

Neuropteris osmundæ (Artis.)

Plate XV., Figs. 1 and 2.

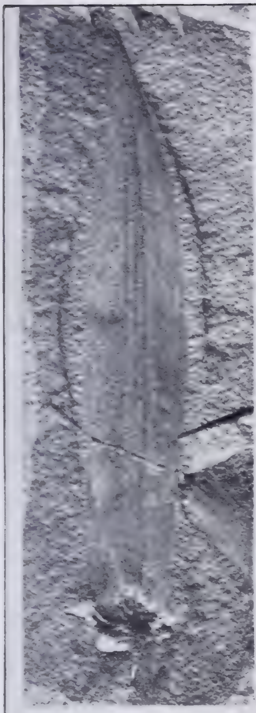
1824. *Filicites osmundæ*, Artis, Antedil. Phytol., p. 7, Plate VII.

1890. *Neuropteris osmundæ*, Kidston, Trans. Yorks. Nat. Union, Part XIV., pp. 42, 75, 91.

1891. *Neuropteris osmundæ*, Kidston, Trans. Manchester Geol. Soc., Vol. XXI., p. 5.

1894. *Neuropteris osmundæ*, Kidston, Trans. Roy. Soc. Edinb., Vol. XXXVII., Part III., p. 591.

The only figure of this rare plant, hitherto published, is that of the type specimen, from Elsecar Colliery, near Wentworth, Yorkshire, of which a very good drawing was given by Artis. This shows the nervation clearly, and emphasises the unequal size of the pinnæ, and the serrated or notched nature of their margins. The plant is also now known from the Middle Coal Measures of South Wales, and South Lancashire, as well as from Nottingham, though it appears to be very uncommon in all these districts.



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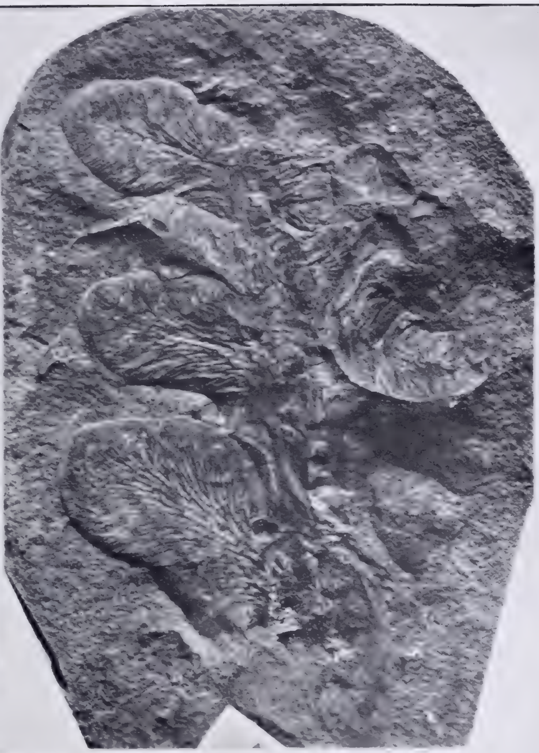

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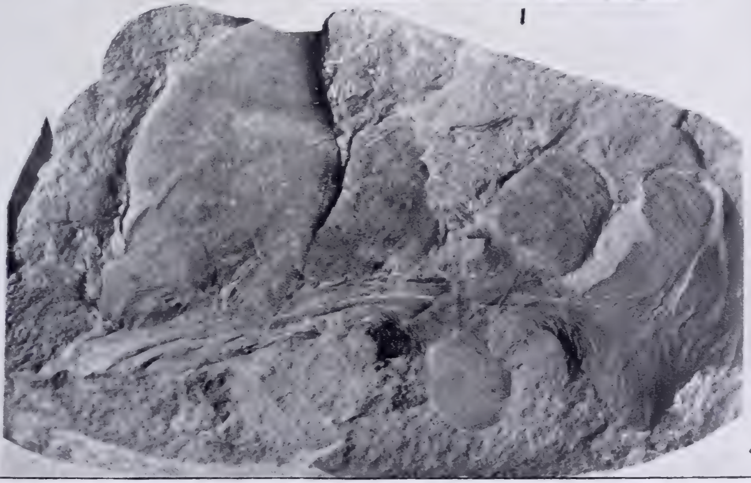

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E. A. N. Arber, Photo.

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Proc. Yorks. Geol. Soc., Vol. XVII., Plate XV.

The photographs of two of Dr. Moysey's specimens of this species, reproduced on Plate XV., Figs. 1 and 2, show the form of the pinnules and the nervation very clearly. The following are the chief characters of this species. Pinnules large, but variable in size and shape, broadly oval or ovate, entire, obtuse, symmetrical or unsymmetrical. Margin serrated, or slightly notched at intervals. Lower extremity of the base sometimes eared. Midrib very inconspicuous and impersistent, dissolving into spreading veins, at a considerable distance from the apex, sometimes scarcely persisting for half the length of the leaflet. Lateral nerves erect, slightly arched and spreading, dichotomising 3-4 times.

Asolanus camptotænia, Wood.

Plate XVI., Fig. 1.

1857. *Sigillaria rimosa*, Goldenburg, Flora Saræp. Foss., Heft. II., pp. 22, 56, Plate VI., Figs. 1-4; Heft. III., p. 43, Plate XII., Figs. 7-8.

1860. *Asolanus camptotænia*, Wood, Proc. Acad. Nat. Sci. Philadelphia, p. 238, Plate IV., Fig. 1.

1866. *Sigillaria camptotænia*, Wood, Trans. Amer. Phil. Soc., Vol. XIII., p. 342, Plate IX., Fig. 3.

1866. *Sigillaria monostigma*, Lesquereux, Report Geol. Surv. Illinois, Vol. II., p. 449, Plate XLII., Figs. 1-5.

1870. *Sigillaria camptotænia*, Schimper, Traité Pal. Végét., Vol. II., p. 101.

1877. *Pseudosigillaria monostigma*, Grand'Eury, Flore Carbon. Depart. Loire, p. 144.

1880. *Sigillaria camptotænia*, Zeiller, Flore foss. bass. houiller Valenciennes, p. 588, Plate LXXXVIII., Figs. 4-6.

1880. *Sigillaria monostigma*, Lesquereux, Coal Flora, Vol. II., p. 468, Plate LXXIII., Figs. 3-6, 1880; Vol. IV., p. 793, p. 1884.

1887. *Sigillaria monostigma*, Kidston; Trans. Roy. Soc. Edinb., Vol. XXXIII., Part II., p. 397.

1890. *Pseudosigillaria monostigma*, Grand'Eury, Bassin houill. du Gard., p. 262, Plate IX., Figs. 4-6.

1890. *Pseudosigillaria dimorpha*, Grand'Eury, *ibid*, Plate IX., Figs. 7-8, Plate XXII., Fig. 1.

1890. *Sigillaria-Camp. monostigma*, Grand'Eury, *ibid*, p. 262, Plate IX., Figs. 4 and 7.

1890. *Sigillaria-Camp. gracilenta*, Grand'Eury, *ibid*, p. 262, Plate IX., Fig. 6, Plate XXII., Fig. 1.

1890. *Sigillaria-Camp. lepidodendroides*, Grand'Eury, *ibid*, p. 262, Plate IX., Fig. 10.

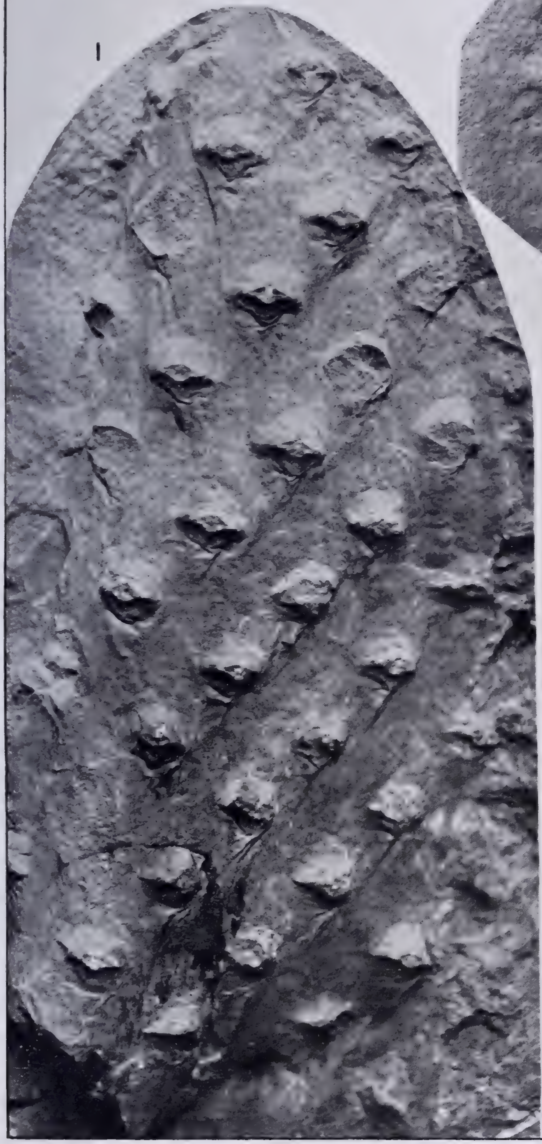
1891. *Sigillaria camptotænia*, Kidston, Trans. Roy. Soc., Edinb., Vol. XXXVI., Part I., p. 86.

1893. *Sigillaria camptotænia*, Kidston, Trans. Roy, Soc. Edinb., Vol. XXXVII., Part II., p. 348.

1894. *Sigillaria camptotænia*, Kidston, Trans. Roy. Soc., Edinb., Vol. XXXIII., Part II., p. 397.

1906. *Asolanus camptotænia*, Zeiller, Bass. houill. et perm. de Blanzy et du Creusot (Etud. Gîtes. Miner.), p. 157, Plate XLI., Fig. 3.

This plant was included in a new genus, *Asolanus*, by Wood in 1860, though he himself transferred it to *Sigillaria* a few years later. Since then, and until quite recently, it has been generally regarded as an example of a non-ribbed Sigillaria (*Subsigillariæ*) of the *Leiodermarian* type, of which it was thought to be one of the few British examples. Within the last few years, however, the tendency has been to restore it to its original genus *Asolanus*, a view which Zeiller and others have adopted, and to regard its affinities, at least provisionally, as more nearly related to *Lepidodendron*, or *Bothrodendron*, than to *Sigillaria*. In *Asolanus*, the leaf-scars are arranged spirally, and not in vertical series, and the prints seen on the leaf-scars do not agree with those found in the case of *Sigillaria*. In *Sigillaria*, there is a central print (the scar of the leaf-trace) flanked by two large scars, the prints of the strands of the parichnos. The leaf-scar of *Asolanus* bears a circular print, within which there may be one or two small, punctate scars. Decorticated Sigillarias show the large paired, and curved scars of the parichnos strands, which are not, however, seen in the corresponding impressions of *Asolanus*, where the scars are single and linear.



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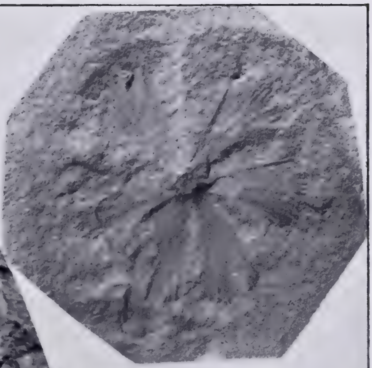

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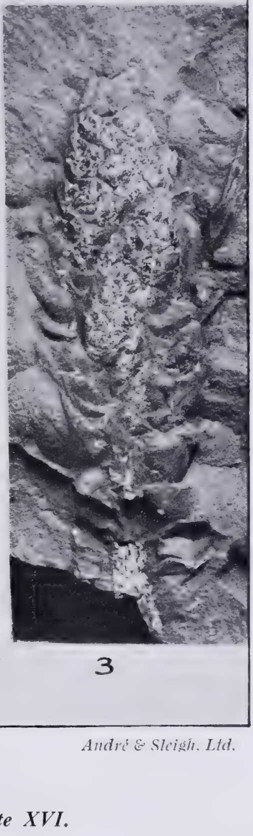

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E. A. N. Arber & W. Tams, Photo. André & Sleigh, Ltd.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XVI.

The fine specimen from Shipley Clay Pit, Derby, collected by Dr. Moysey, and figured on Plate XVI., Fig. 1, shows the spiral arrangement of the leaf-bases very clearly, and the fact that the leaf scars are mounted on prominent leaf-bases, which merge gradually into the bark, their margins being ill defined. The whole specimen is 15 cm. long, and 5.5 cm. broad. Seven spirals of leaf-bases are seen, though in several cases the distal portion of the leaf-base has been broken.

The highest	spiral	shows	2	complete	and	2	broken	leaf-bases.
The 2nd	,,	,,	4	,,	,,	1	,,	,,
The 3rd	,,	,,	3	,,	,,	3	,,	,,
The 4th	,,	,,	2	,,	,,	4	,,	,,
The 5th	,,	,,	1	,,	,,	5	,,	,,
The 6th	,,	,,	1	,,	,,	4	,,	,,
The 7th	,,	,,	1	,,	,,	1	,,	,,

The spirals are about 1.8 cm. or less apart, and the leaf-bases of successive spirals alternate. The leaf-scars of each spiral are distant about 1 cm. or more. The bark between the leaf-bases is more or less smooth, with irregular, discontinuous, somewhat faint, longitudinal striæ, either vertical or oblique.

The leaf-scar is 6.5 mm. long, and 2.5 mm. across at its widest point. The lateral angles are small, sharp, and prolonged. The upper margin of the scar is flattened, the lower rounded. The prints on the leaf-scar are very indistinct, but one or more very minute " pin's-head " prints can be seen here and there.

Lepidostrobus triangulare, (Zeiller.)

Plate XVI., Fig. 3.

1886. *Lepidophyllum triangulare*, Zeiller, Flore Foss. Bass. Houill. Valenciennes, p. 508, Plate LXXVII., Figs. 4-6.

1896. *Lepidophyllum triangulare*, Kidston, Trans. Yorkshire Nat. Union, Part XIX., p. 140.

This cone, which in Britain is very infrequent, nearly always occurs in a fragmentary condition, the small, spear-head shaped bracts being isolated. They are then spoken of as *Lepidophyllum triangulare*. In the excellent example in Dr. Moysey's collection, the cone is almost complete, a rare circumstance, and yet the form of the bracts can be made out, especially near the base.

Trigonocarpus sp.

Plate XVIII., Fig. 1, Plate XIX., Fig. 3.

1899. *Trigonocarpus* sp., Arber, Fossil Plants, Fig. on p. 42.

The two halves of a nodule, containing a fine specimen showing the external surface of a seed of *Trigonocarpus*, are figured on Plate XVIII., Fig. 1*, and Plate XIX., Fig, 3. The broad, wing-like portion is formed by the fleshy seed-coat or sarcotesta, the oval, central portion is the hard seed-coat or sclerotesta, of the body of the seed, which is prolonged upwards as a long micropylar tube[1].

Impressions of the external surface of *Trigonocarpus* are rare as compared with casts of the seed cavity, such as *Trigonocarpus parkinsoni* Brong., and *T. nœggerathi*, Sternb. The external surface of the seed, whose internal cast is known as *T. parkinsoni* Brongn., is probably that first figured by Lindley and Hutton[2] under the name *Carpolithes alata*, of which excellent examples have also recently been figured by Scott and Maslen[3]. As compared with this species, the present specimen appears to be much shorter in proportion to its breadth, the micropyle being shorter and the seed broadly oval in form, rather than elongately elliptical. It is probably distinct specifically from *Carpolithes alata*, and perhaps *T. nœggerathi*, Sternb. may have been the corresponding internal cast of the seed cavity, though of this there is no evidence at present. This type of seed has, however, been found from the Upper Coal Measures, where *T*, *nœggerathi* occurs, but not *T. parkinsoni*. For the present, however, it does not seem advisable to suggest a new specific name for what is probably only a rare state of preservation of a common fossil.

Sphenopteris (*Corynepteris*) *coralloides*, Gutbier.

Plate XVIII., Fig. 3, Plate XIX., Fig. 2.

1835. *Sphenopteris coralloides*, Gutbier, Abdrücke Verstein., Zwickau. Schwarzkohl., p. 40, Plate V., Figs. 8, 8A.

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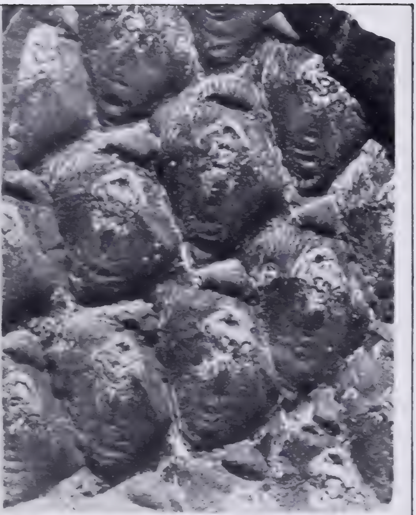
* One half of this specimen was figured in my "Fossil Plants," Gowan's Nature Series No. 21, p. 42.

[1] For the structure of this type of seed, see Scott and Maslen (07).

[2] Lindley & Hutton (31). Vol. II. Pl. 87, Fig. 2 and 3, Vol. III. Pl. 210, Fig. B.

[3] Scott & Maslen, (07), Pl. XII., Fig. 16 and 17, Pl. XIII., Fig. 18.



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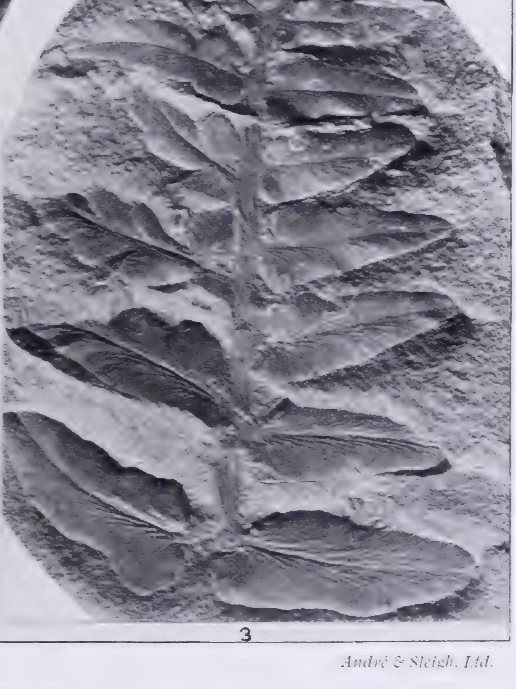

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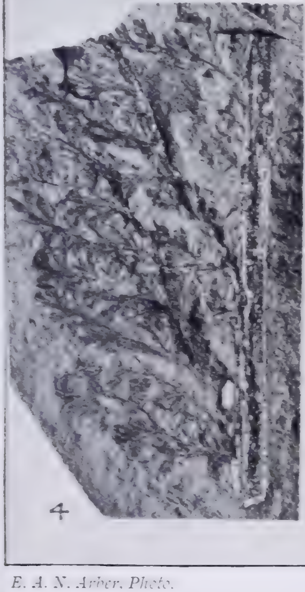

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E. A. N. Arber, Photo.

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Proc. Yorks. Geol. Soc., Vol. XVII., Plate XVII.

1855. *Sphenopteris coralloides*, Geinitz, Verst., Steink., Sachsen, p. 16, Plate XXIII., Fig. 17.

1881. *Sphenopteris microloba*, Weiss, Aus d. Steinkohl. (2nd Edit.), p. 13, Plate XII., Fig. 79.

1883. *Grand'Eurya coralloides*, Zeiller, Ann. Sci. Nat. Ser. 6, Bot., Vol. XVI., pp. 206, 209, Plate XII., Figs. 1-8.

1885. *Saccopteris crepini*, Stur., Abhandl. k. k. Geol. Reichsanst. Wien, Vol. XI., Part I., p. 174, Plate LIII., Figs. 1, 2.

1886. *Sphenopteris* (*Corynepteris*) *coralloides*, Zeiller, Flore Foss. Bass. Houill. Valenciennes, p. 117, Plate X., Figs. 1-5.

Dr. Moysey has collected examples both of the delicate and graceful, sterile foliage of this plant (Plate XIX., Fig. 2), and also of the fertile pinnæ (left-hand side of Plate XVIII., Fig. 3) from the shales of Newthorpe Clay Pit, Nottinghamshire. He has also obtained both fronds, fertile and sterile, in continuity, which I believe is the first time such connection has been observed in British specimens, though Prof. Zeiller was able to demonstrate the fructification of this frond from French examples many years ago. The fructification of this plant is known as *Corynepteris*[1], Bailey.

A note on Lepidodendron similis, Kidst., M.S.

In a recent memoir, Jongmans[2] mentions a new M.S. species of Dr. Kidstons *Lepidodendron similis*, of which the following is given as the synonymy.

1834. *Lepidodendron elegans*, Lindley & Hutton, Fossil Flora, Vol. II., Plate CXVIII.

1837. *Lepidodendron elegans*, Brongniart, Hist. Végét. Foss., Vol. II., p. 35, Plate XIV.

1880. *Lepidodendron lycopodioides*, Zeiller, Végét. Foss. Terr. Houill, France, p. 111, Plate CLXXI.

1882. *Lepidodendron lycopodioides*, Renault, Cours. Bot. Foss., Vol. II., p. 14, Plate V., Fig. 8.

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[1] Kidston (89), p. 16, Pl. II., Fig. 17.

[2] Jongmans (09).

1886. *Lepidodendron lycopodioides*, Zeiller, Flore Foss. Bass. Houill. Valenciennes, p. 464, Plate LXIX., Figs. 2-3, Plate LXX., Fig. 1.

No description of this species has yet been published, nor is it evident by what characters this plant differs from *Lepidodendron lycopodioides* of Sternberg; a species around which much uncertainty has already centred. For the present it may be noted that among Dr. Moysey's collection, several specimens similar to the figures above mentioned, are to be found.

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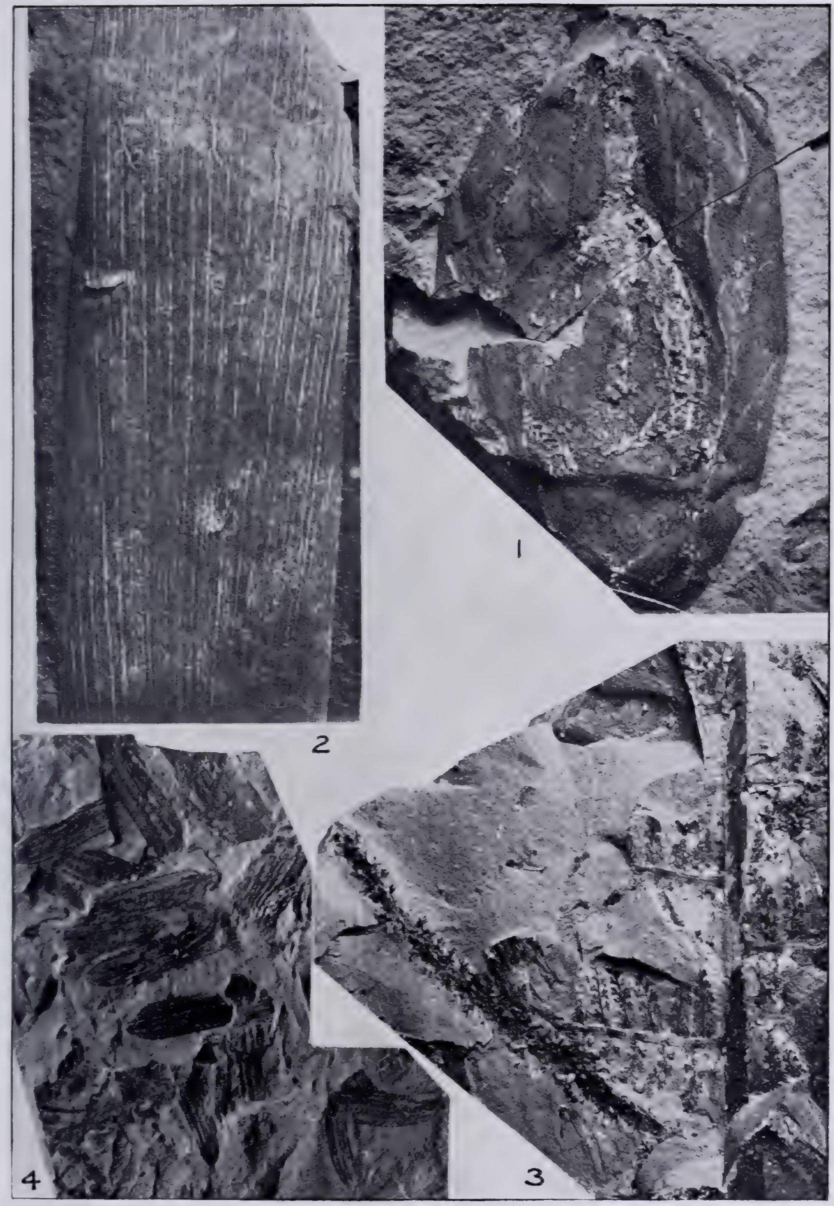

E. A. N. Arber, Photo.

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Proc. Yorks. Geol. Soc., Vol. XVII., Plate XVIII.

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EXPLANATION TO THE PLATES.

(All the figures are from photographs by the Author (except Plate XVI., Fig. 1, by Mr. W. Tams) of specimens in the collection of Dr. Moysey, F.G.S., of Nottingham, unless the contrary is stated.)

Plate XII.

Fig. 1.—*Palæostachya gracillima*, Weiss, from the Middle Coal Measures of Brindsley Clay Pit (Horizon of Top Hard Coal), Kimberley, Nottinghamshire. Very slightly reduced.

Plate XIII.

Fig. 1.—*Calamites* sp. Cast of the external surface of a stem, from the Lower Coal Measures of Trowell Colliery, Nottinghamshire (Horizon of the Kilburn Coal) × $\frac{3}{2}$.

Fig. 2.—*Calamites* sp. Reverse of Fig. 1, from the same locality × $\frac{3}{2}$.

Fig. 3.—*Calamites approximatus*, Brongn., from the Middle Coal Measures of Newthorpe Clay Pit (No. 1), Notts. (Horizon between the Waterloo and the Ell Coals) $\frac{5}{7}$ of natural size.

Fig. 4.—*Zeilleria avoldensis* (Stur), from the Middle Coal Measures of Shipley Clay Pit, Derby. Horizon of the Top Hard Coal) × $\frac{7}{5}$.

Plate XIV.

Fig. 1.—*Eremopteris moyseyi*, n. sp., from the Middle Coal Measures of Digby Clay Pit, Kimberley, Notts. (Horizon of the Top Hard Coal) × $\frac{5}{4}$.

Fig. 2.—*E. moyseyi*, n. sp. Reverse of Fig. 1 × $\frac{5}{4}$.

Fig. 3.—*Alethopteris davreuxi*, Brongn., from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). $\frac{7}{8}$ of natural size.

Plate XV.

Fig. 1.—*Neuropteris osmundæ*, (Artis), from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). Natural size.

Fig. 2.—*Neuropteris osmundæ*, (Artis), from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). $\frac{8}{9}$ of natural size.

Fig. 3.—*Lepidophyllum majus*, Brongn., from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). Very slightly enlarged.

Plate XVI.

Fig. 1.—*Asolanus camptotænia*, Wood, from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). Natural size.

Fig. 2.—*Sphenophyllum majus*, Brongn., from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). Natural size.

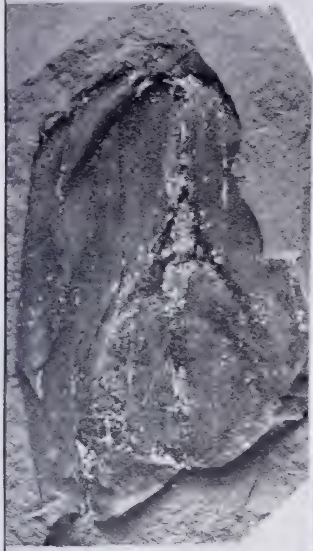
Fig. 3.—*Lepidostrobus triangulare* (Zeiller), from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). Very slightly enlarged.

Plate XVII.

Fig. 1.—*Lepidodendron obovatum*, Sternb., from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). × $\frac{6}{5}$.

Fig. 2.—*Bothrodendron minutifolium* (Boul.), from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). Natural size.

Fig. 3.—*Neuropteris acuminata*, (Schloth.), from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). × $\frac{5}{4}$.



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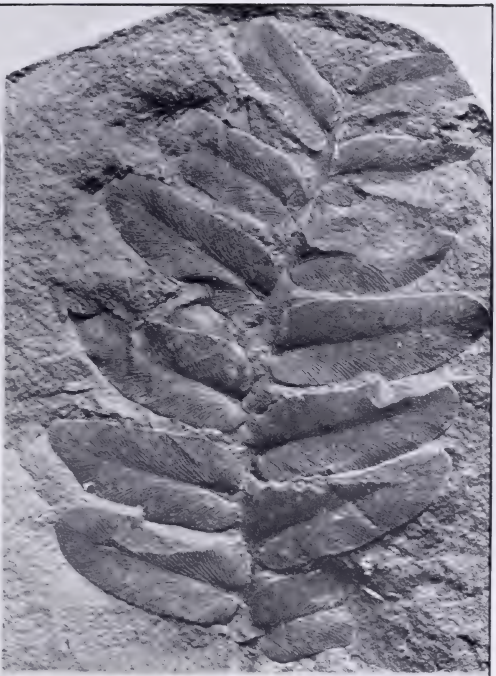

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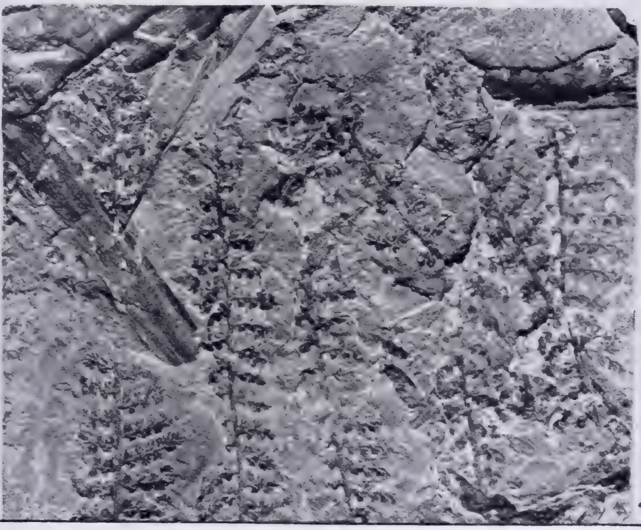

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Proc. Yorks. Geol. Soc., Vol. XVII., Plate XIX.

Fig. 4.—*Sphenopteris* (*Urnatopteris*) *tenella*, Brongn., from the Middle Coal Measures of Digby Clay pit. (Horizon of the Top Hard Coal). × $\frac{9}{7}$.

Plate XVIII.

Fig. 1.—*Trigonocarpus* sp., from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). × $\frac{7}{4}$.

Fig. 2.—*Cordaites principalis* (Germar), from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon below the Top Hard Coal). No. 1886 Carbon. Plant Coll. Sedg. Mus. Camb. $\frac{3}{4}$ natural size.

Fig. 3.—*Sphenopteris* (*Corynepteris*) *coralloides*, Gutbier, from the Middle Coal Measures of Newthorpe Clay Pit (No. 1), Nottinghamshire. (Horizon below the Waterloo Coal). × $\frac{7}{5}$.

Fig. 4.—*Rhabdocarpus elongatus*, Kidst., from the Lower Coal Measures of Trowell Colliery, Nottinghamshire. (Horizon of the Kilburn Coal). × $\frac{13}{10}$.

Plate XIX.

Fig. 1.—*Neuropteris tenuifolia* (Schloth.), from the Middle Coal Measures of Shipley Clay Pit, Derby. (Horizon of the Top Hard Coal). Slightly enlarged.

Fig. 2.—*Sphenopteris* (*Corynepteris*) *coralloides*, Gutbier, from the Middle Coal Measures of Newthorpe Clay Pit (No. 1), Nottinghamshire. (Horizon below the Waterloo Coal). × $\frac{5}{4}$.

Fig. 3.—*Trigonocarpus* sp. The reverse of Plate VII., Fig. 1 × $\frac{5}{3}$.

In Memoriam.

CHARLES EDWARD FOX-STRANGWAYS, F.G.S

(1844-1910).

The past year has become sadly memorable in the annals of the Society by the death of two members of long standing, whose official work for the Geological Survey was done mainly in Yorkshire, and whose share in the geological mapping of the county was greater than that of any other members of the surveying staff. The majority of the Yorkshire maps and memoirs of the Survey are a monument to the labours of C. E. Fox-Strangways and J. R. Dakyns.

C. E. Fox-Strangways was born on February 13th, 1844, at Rewe, near Exeter, where his father, the Rev. H. Fox-Strangways (a grandson of the first Earl of Ilchester) was Rector. The future geologist received his schooling at Eton, and went afterwards to the University of Göttingen, where chemistry, mineralogy and physics were the subjects to which he devoted especial attention. While at Göttingen, he saw something of the turmoil of the war of 1866, when Hanover was invaded by the Prussian troops, and the events of that year were always an outstanding recollection to him. Returning to England, he joined the staff of the Geological Survey in 1867 as Assistant-Geologist, proceeding to the rank of Geologist in 1879, and of District Geologist in 1901.

His first field work for the Survey was done on the Carboniferous rocks of Yorkshire, in the neighbourhood of Todmorden and Halifax. Afterwards he worked in the northern part of the coalfield near Bradford ; likewise in the Ingleton district. Later, he surveyed the eastern side of the great anticline, in the neighbourhood of Harrogate and Knaresborough ; and from there his work was carried across the Vale of York to the Jurassic and Cretaceous rocks of the Eastern Moorlands and the Wolds, his survey of these rocks eventually extending into northern Lincolnshire. He had his home in Scarborough during the period of his duties in North and East Yorkshire, and his interest in the Eastern Moorland country never waned.

(Photo, Maull and Fox, London.)

Yours very truly
C. Fox Strangways

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XX.

On being transferred to the Midlands in 1889, he changed his residence to Leicester and remained there until his retirement from the Survey in 1904, when he removed to the neighbourhood of London. During his later years on the Survey he mapped the Leicestershire coalfield and the surrounding country, northward beyond Charnwood Forest to the Trent and eastward to Melton Mowbray. Impaired health, due to an affected heart, debarred him from hard exertion in the field after his retirement, and gradually curtailed his activities in most directions, but he carried on his scientific literary labours to the end. Death overtook him suddenly at his desk on March 5th, 1910, just as he was finishing an exhaustive bibliography of Yorkshire Geology. He was buried in his native Devonshire village. He was a widower and had no children.

The major part of Fox-Strangways' scientific writings is embodied in the Memoirs of the Geological Survey, twenty-two of which carry his name either as sole author or part author. Among those which were written entirely by him are the two well known volumes containing a general account of the Jurassic rocks of Yorkshire, also the smaller "sheet" memoirs on the country north and east of Harrogate; on the country south of Scarborough; on the country north and west of Malton; on the country north-east of York and south of Malton; and on the underground water supply of the East Riding. In the Midland district he was likewise entirely responsible for memoirs on the Leicestershire and South Derbyshire Coalfield; on the country between Atherstone and Charnwood Forest; on the country near Leicester; and on the country between Derby and Loughborough. (The full titles of all the memoirs to which he contributed, as well as of his principal unofficial papers are contained in an obituary notice which appeared in the Geological Magazine for May, 1910; dec. 5, vol. VII., pp. 235-8).

Among the papers which he published unofficially were several in our Proceedings;—on the Harrogate Wells, in 1885; on Glacial Phenomena near York in 1895; on the Coast between Redcar and Scarborough, in 1897; on Filey Bay and Brigg, in 1898; and on the Coast between Hayburn Wyke and Filey in the same year. He further contributed an important paper on the Valleys of North-east Yorkshire and their mode of formation to the Transactions of the Leicester Lit. and Phil. Soc., in 1894.

Fox-Strangways was elected into our Society in 1878 (the present writer being among the others elected at the same meeting). He had become a Fellow of the Geological Society of London in 1873, and he served on its council during the years 1905-8. He was likewise an honorary member of the Yorkshire Philosophical Society. While living in Scarborough, he rendered great services to the local museum by re-arranging its classical collection of Jurassic fossils. In Leicester, he took an active part in the working of the geological section of the Leicester Lit. and Phil. Society, and was helpful to its members in many ways.

Reticent and unassuming in manner, Fox-Strangways pursued his life's work with a quiet earnestness and persistence of endeavour that never courted recognition. His experiences of the world were wide and varied ; the range of his travels included parts of North America, South Africa, Iceland and Spitzbergen, as well as many parts of Europe ; but he rarely submitted his wide knowledge of men and things, even to his closest acquaintances.

His disposition was essentially placid and amiable ; and his circle of friends was large, though few could claim intimacy with him. His high qualities as a field geologist and his methodical accuracy and patience with detail are splendidly exemplified by his six-inch maps of the Eastern Moorlands, which are likely to be treasured as standards of what may be achieved by detailed mapping in an area of regular stratigraphy and bold surface-relief.

The sincerity of his interest in Geology is shown by the fact that he continued his labours in the science with the same steady persistence after his retirement from official work. His complete bibliography of Yorkshire Geology, prepared with infinite patience during the last two or three years of his life, and to which Death so swiftly added an irrevocable colophon, has been handed over by his executors to our Society in M.S., and will be published shortly. It will fitly serve as his memorial ; and this, as I know, was his wish

G. W. LAMPLUGH.

I am Yrs truly

J. R. Dakyns

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXI.

In Memoriam.

JOHN ROCHE DAKYNS, M.A.

(1836—1910.)

Of late, Death has struck heavily into the foremost rank of Yorkshire Geologists. Sorby, Hudleston, Fox-Strangways are gone. And now we have to lament the loss of another veteran, in the death of J. R. Dakyns, which occurred, after a mercifully brief illness, on September 27th, at Snowdon View, Gwynant, near Beddgelert, where he had resided for some years past. Though his residence in Yorkshire terminated over twenty-five years ago, he will be well remembered by the older geologists of both the East and the West Riding, and by his many friends outside the geological circle.

John Roche, the eldest of six sons, was born on January 31st, 1836, in the Island of St. Vincent, West Indies, where his father, Dr. T. H. Dakyns, held estates and pursued his medical profession. The family removed to Rugby in 1845, and the future geologist was educated there, at first in a preparatory school, under the Rev. T. L. Bloxam, and afterwards at Rugby School. In 1855 he went up to Trinity College, Cambridge; was elected a scholar of his College in 1858; and graduated with distinction in 1859, being bracketed 27th Wrangler in the Mathematical Tripos. He took the degree of M.A. in 1864.

In 1862 he was appointed to the staff of the Geological Survey as Assistant-Geologist, proceeding to the rank of Geologist in 1868. His earlier work for the Survey was done mainly in the West Riding, and just across its border, in Westmoreland, Cumberland, Lancashire and Derbyshire. About the year 1877 his field of work was changed to the East Riding—much to his distaste, for the Dale country had cast its charm over him. During the next three or four years he mapped the northern part of Holderness and the neighbouring Wolds. He became a Member of our Society in 1879.

After some further work in the west of our county, he was transferred in 1884 to the South-west Highlands of Scotland, where his field lay chiefly in the shires of Perth and Argyle. Ten years later he was sent to assist in the mapping of South Wales, and spent two years there. In 1896, he retired from the Survey, after a service of 34 years.

In the course of his official work he had contributed, as part-author, to fourteen memoirs, nearly all relating to Yorkshire. He wrote also numerous short pithy papers, always packed with acute observation and enlivened by a characteristic style, which were published in the Quarterly Journal of the Geological Society, the Geological Magazine, and the Proceedings of the Yorkshire Geological and Polytechnic Society. A list of these papers and of the official memoirs has been published in "The Naturalist" for Nov., 1910. Those of us who know him best, however, have felt that his published work gave but a faint reflection of the extent of his knowledge and attainments. This discrepancy was due partly to his dislike for the trouble of writing, but perhaps still more to the severely logical turn of his mind, which was never satisfied with anything short of absolute demonstration, even, when, from the nature of the case, the full evidence he desired was palpably unattainable. In Geology, as in the practical affairs of life, it is often only possible to strike the balance of probabilities; but this was a course to which Dakyns hated to be driven.

When his retirement from the Survey gave him freedom of choice, he went with delight to dwell among the mountains of North Wales, for which, from the time of his early holidays, he had maintained a longing affection; and there the remaining years of his life were spent. At first he came down occasionally in the winter to visit his friends on the plain, but latterly he never left his valley under the peaks of Snowdon; and now he lies buried at Beddgelert, overlooked by the peaks that he loved so well.

During these years in Wales he applied himself to the arduous task of mapping the Snowdonian massif geologically on the six-inch scale. A large portion of the work was accomplished, but it is left incomplete and unpublished. There is hope, however, that his labour will not be lost, for it is likely to be continued by one of his closest friends.

His bent toward Natural Science was indicated in his boyhood by his devotion to the study of birds and by his gentle care for them—traits which were sustained to the end of his life. (I well recall his agitation, during my penultimate visit to him in Wales, lest a big owl that had strayed into the valley should become a victim to the gunners who were in chase of it.) During his college career, mathematics and astronomy were the subjects that especially attracted him; but the range of his intellectual interests became ever wider and more varied, and he read deeply and earnestly in philosophy, history and anthropology, while the old folk-lore stories were always his recreation and delight. Combined with an intellect of exceptional acuteness and insight, he possessed a charming frankness and simplicity of character that gained him friends in every rank. His personality was striking; his disposition, truly lovable; and his life's path was everywhere marked by deeds of unobtrusive generosity and kindness. He remained unmarried, though his tenderness towards children was always notable. His affection for all dumb animals was unbounded; and his whole-hearted devotion to his favourite dog is likely to become legendary in the valley of his last abode.

Such are the main facts of his life. And, finally let me touch a note of personal appreciation and gratitude; for, by the death of J. R. Dakyns, I have lost a friend to whom I owe more than can ever be expressed. We became acquainted on his first coming into the East Riding over 30 years ago, while I was still in the rawness of youth; and our companionship from that time onward was constant. He had travelled much in his younger days, in Iceland, Norway, Switzerland; and not only had he read widely and wisely, but he had also counted among his friends some of the keenest intellects of his time; so that our converse was indeed to me 'a liberal education.' At first, I remember, I was almost alarmed by the sudden fierceness of his denunciation when some act of cruelty or injustice came to his notice, or occasionally, it may be, when I had slid into some crude sophistry or slack logic; but the storm would pass quickly into sunny tolerance and gentle reprimand, and the lesson was the more memorable from its vigorousness. His dislike for any inaccuracy of statement was intense, and the pains he constantly took to convey the exact impression of what was in his mind could not fail to have its influence upon any companion. The sincerity and earnestness of his mental attitude was such that no one, and especially no young man, could have the privilege of his friendship without benefitting greatly thereby; and I well know that it was not in my own case alone that this benefit was felt and acknowledged. The full measure of his service to Science is not comprised within the limits of his personal achievement; his influence remains among us in many quarters; and he has left a lasting memory in the hearts of his friends.

G. W. Lamplugh.

[Note.—The drawing (Plate XXI.) has kindly been made by Miss Barrow from several photographs of Mr. Daykns taken in the field by his colleague, Mr. G. Barrow, F.G.S.—*Ed.*]

REPORT OF THE HONORARY SECRETARIES, 1910.

The work of the Society continues to develop successfully, and the membership shows that Yorkshire geologists give vigorous support to their County Society.

During the year, nine new members have been elected. We have suffered several deeply regretted losses by death. Sir Charles Strickland, Bart., elected in 1879, died at the ripe age of 90 years. Mr. C. Fox-Strangways, a well-known member of H.M. Geological Survey, will long be remembered by Yorkshire geologists for his thorough work on the formations of Central and Eastern Yorkshire. He had been a member since 1879, and was engaged on a Bibliography of Yorkshire Geology, at the time of his death. Another well-known member of the Geological Survey, who passed away suddenly on September 27th, was Mr. John R. Dakyns, who did important survey work in Yorkshire and the neighbouring counties for 22 years. He joined our Society in 1879 and contributed several papers to our Proceedings. We also regretfully drop the names of G. W. Haldane, F. Whiteley, John Pollard, and Abraham Crossley, who have for years given their valued support to our Society. In addition to these removals by death, there have been eleven resignations, leaving the membership at the total of 213.

The General Meetings and Field Excursions have been carried out under favourable climatic conditions, and were full of geological interest.

The Spring Meeting was held at Leeds on March 4th, in the Geological Department of the University, by the kind permission of our President (Prof. P. F. Kendall) and the Vice-Chancellor. A paper by Dr. Wheelton Hind "On four new Carboniferous Nautiloids and a Goniatite new to Great Britain" was read, in the absence of the author, by Mr. A. Gilligan. Mr. Frank White's paper on "The Igneous Rocks of the Isle of Man," was summarized by the President, in the absence of the author, and Mr. Cosmo Johns gave a paper on "The Basement Beds of the Lower Carboniferous Rocks of N.W. Yorkshire." Each of these papers was followed by an interesting discussion, and the meeting concluded with a vote of thanks to the readers of the papers, to the authorities of the University, to Professor Kendall for the use of the room, and to Mr. A. Gilligan, B.Sc., for arranging an exhibit of tectonic models. Earlier in the day a party visited the Ganister Quarry at Meanwood, and inspected the latest section of the folded and faulted strata. Messrs. E. Parsons, B.Sc. (Leeds) and Gilbert Y. Tickle, H.M. Inspector of Mines (Leeds), were elected members.

The Easter Field Excursion was taken to Filey. Messrs. J. W. Stather, F.G.S., and T. Sheppard, F.G.S., prepared an excellent programme, and did much to make the meeting enjoyable and instructive. On Friday, March 25th, the party walked to Gristhorpe and Cayton Bays, and found the sections well-exposed. In the evening the General Meeting was held at the Royal Crescent Hotel, with Mr. G. W. Lamplugh, F.R.S. as Chairman, in the unavoidable absence of the President. An interesting conversation on the local geology was initiated by the Chairman and was continued by Mr. Stather and several other members. Congratulations were offered to Mr. A. Wilmore on attaining the degree of Doctor of Science in the University of London. On Saturday, March 26th, the party walked along the foreshore to Speeton and examined the drift sections in the cliffs, which included large boulders of transported Lias, which yielded specimens of Ammonites new to Yorkshire. At Leighton and Speeton exposures in the "Speeton Shell Bed," Kimmeridge Clay and Red Chalk were examined, and their characteristic fossils collected. On Monday, March 28th, a visit was paid to Bridlington, where the cliff sections of the Post-Glacial and Pre-Glacial beds were examined. The headland was crossed to Flamborough North Landing and sections in the Chalk round Thornwick Bay were examined. The Chairman pointed out interesting evidence that the headland had only been recently cleared of its enveloping glacial beds, and patches of boulder-clay were seen still filling up hollows in the ancient chalk cliffs. He also explained the formation of the suture-like markings and the marl bands in the Chalk.

The Summer Meeting was held at the Rose and Crown Inn, Bainbridge (Wensleydale) on June 18th, when Messrs. Bernard Hobson, M.Sc. (Sheffield), Ronald Sykes (Huddersfield), and Joseph Walker (Huddersfield), were elected members. The President opened a discussion on the geological features of Wensleydale, which was continued by Mr. Cosmo Johns, Mr. Wm.

Horne, and other members. The meeting concluded with votes of thanks to the landowners for permission to visit their estates, and to Mr. Lodge, of Bainbridge, for placing his local knowledge at the disposal of the party. An interesting programme of field work was arranged by Messrs. W. Horne, F.G.S., and J. Hartshorn. On Friday, June 18th, an excursion was made to the Gap of the Bain to see the havoc wrought by a flood two years ago, after which Semmerwater and Parker Gill Force were visited, and, on the return route, the " British Dwellings " on Addborough Top and the denudation on Scar Top by the storm of 1908 were examined. On Saturday, June 19th, Mill Gill, Whitfield Gill, and Whitfield Crags (Askrigg) were visited, and on the return journey a detour was made to Skell Gill. On the following Monday the Scars of Ellerkin, Nappa, and Catleap were visited.

The Autumn Meeting was held at the Queen's Hotel, Sunderland, under the Chairmanship of the Rev. C. T. Pratt, M.A., in the unavoidable absence of the President. The leadership of the party was in the capable hands of Dr. David Woolacott, of Newcastle, who has made a careful study of the district. The sections from Hendon to Ryhope with concretionary and flexible limestones, intruded and slickensided breccias, and the Lower Permians at Claxheugh were examined on Friday, September 16th, and on the following day the coast sections from South Shields to Marsden were visited. At the General Meeting an address was given by Dr. Woolacott, who explained that he had lately been able to prove that the extensive brecciation that forms such a marked feature of the Magnesian Limestone in Durham had been produced by horizontal thrusts acting roughly between the north-west and south-west directions. This pressure had shattered the strata and displaced large masses, and also developed extensive fracturing, folding, cleaving, slickensiding, and other structures that are characteristic of thrusted regions. In some cases the breccias have been forced into the beds above, and, in one place at least, into the bed beneath. In his examination Dr. Woolacott had found it necessary to re-classify and re-map the principal beds of the north-east of Durham. The most interesting fact brought out by this survey was that the Shell Limestone of Howse or King was a shell-bank of the Permian sea. During their visit he had been able to show the party the whole of the divisions of the Permians, viz., the æolian deposit of the Yellow Sands, the fossiliferous Marl Slates, the regularly-bedded Lower Calcareous Beds, the irregularly deposited Middle Limestones and the flexible concretionary and other strata of the Upper Division. It is in the Middle Calcareous member that the great unbedded fossiliferous limestone occurs, and it is also in these beds, and the lower strata of the upper rocks, that the thrust phenomena are best seen. The party also were able to examine the uppermost Coal Measures of the Northumberland and Durham Coalfield, the boulder-clay, an esker at Grindon, and the gravels and sands with marine shells. This last deposit was seen on the 150-foot contour at Marsden, and at the same level resting upon true boulder-clay at Fulwell, about three miles southwards. It was also observed at Cleadon between these points on the 100-foot contour and fragments of shells had been collected there of species such as live in the neighbouring sea. This formation is obviously a shore deposit and represents either a true raised beach or the marginal deposit of a lake held up by ice in the North Sea at the end of the Glacial Period. The address was illustrated by diagrams and photographs and a hearty vote of thanks to Dr. Woolacott for his valued leadership and instructive address was given. On Monday, September 19th, a visit was paid to the Boldon Hills, along the flanks of which the Lower Permian rocks were clearly displayed, including disturbed beds and overlying fossiliferous limestones and breccias. Some of the party also visited Cullercoats and Tynemouth in order to examine the relations of the Lower Permian to the underlying Coal Measures.

Efforts were made in June to organise a field excursion to Belgium to examine the Devonian and Lower Carboniferous rocks of that region, but it was found impossible to arrange for a time when a sufficient number of members could attend.

The Council passed a resolution of congratulation to Mr. John W. Stather, F.G.S., on the award to him of the Lyell Fund by the Geological Society of London.

Mr. J. G. Robinson, J.P., acted as delegate to the Corresponding Societies Committee at the Sheffield meeting of the British Association. Two of our members, Mr. W. Lower Carter (Recorder), and Dr. A. R. Dwerryhouse, were officers of Section C (Geology).

Negotiations were entered into by the Council last year with Mr. C. Fox-Strangways with regard to the publication of a complete Bibliography of the Geological Literature of Yorkshire, to the compilement of which he had devoted the past five years. The sudden death of Mr. Strangways interrupted these negotiations, but ultimately the M.S. was handed over to the Editor by Mr. G. W. Lamplugh, with the view of its publication. The Council have carefully considered the advisability of the publication of this important Bibliography and have decided to print it next year and to issue it to each member.

Dr. Dwerryhouse, having resigned the Editorship of the Proceedings on his removal to Belfast, the Council have nominated him for the Vice-Presidency vacant owing to the death of Mr. Fox-Strangways.

Mr. W. Lower Carter having expressed his wish to be relieved from the Secretarial duties which he had undertaken as co-adjutor of Mr. Cosmo Johns, the Council unanimously nominated Mr. Edwin Hawkesworth, Secretary of the Leeds Geological Society, as co-Secretary, and nominated Mr. Carter as Editor of the Proceedings.

The Council invited Professor P. F. Kendall to allow his name to be submitted to the Annual General Meeting as President for 1911.

The Programme for 1911 is provisionally arranged as follows :—

Easter.—South of Scotland, for Igneous Rocks.

June 16*th and* 17*th.*—District West of Ingleton, for Ingleton Coalfield, Permians and Lower Carboniferous of Bentham.

September 15*th and* 16*th.*—Hull as centre. For Hornsea, Withernsea, and Spurn Point.

The Proceedings, as usual, have been forwarded to the principal Scientific Societies of the world, and publications have been received in exchange as in previous years.

W. LOWER CARTER.
COSMO JOHNS.

THE YORKSHIRE GEOLOGICAL SOCIETY.

Statement of Receipts and Expenditure from October 31st, 1909, to October 31st, 1910.

REVENUE ACCOUNT.

Dr.

1909.	**Receipts.**	£	s.	d.
Nov. 1	To Allowance by Chorley & Pickersgill	1	1	0
	,, Members' Annual Subscriptions ..	79	6	0
	,, Members' Arrears Received ..	9	15	0
	,, Interest on Mortgage Bonds of Halifax Corporation	12	3	10
	,, Received for Authors' Reprints ..	0	14	6
	,, Sales of Proceedings	7	9	2
		£110	9	6

Cr.

1909.	**Expenditure.**	£	s.	d.	£	s.	d.
Nov. 1	By Balance owing from last year				12	7	7
	,, Expenses of Meetings, per Hon. Secretaries :—						
	Bradford, Appleton & Co., Lantern ..	1	10	0			
	Gainsborough ..	0	17	0			
	Filey	5	18	0			
	Leeds Council Meeting	1	4	4			
					9	9	4
	,, Postages and Sundries per Hon. Secretary ..				1	18	11
	,, Postages and Sundries, per Hon. Treasurer ..	0	18	10			
	,, Stationery, do. ..	0	18	6			
					1	17	4
	,, Expenses per Hon. Librarian ..				2	10	11
	,, Rosemont " Plate "				1	6	3
	,, Griffin & Co.				0	6	0
	,, Chorley & Pickersgill, Proceedings, &c.				59	3	9
	,, Balance in Bank				21	9	5
					£110	9	6

CAPITAL ACCOUNT.

1910.		£	s.	d.
Oct. 31	To Halifax Corporation Mortgage Bonds	370	0	0
	,, To Books, Proceedings, Maps, &c., at the Leeds University (as per Agreement dated 20th November, 1907, in the custody of the Halifax Joint Stock Banking Co)			
		£370	0	0

1909.		£	s.	d.
Oct. 31	By Halifax Corporation Mortgage Bonds	370	0	0
		£370	0	0

Leeds, November 3rd, 1910.

Examined and found correct, F. W. BRANSON, *Hon. Auditor.*

WILLIAM SIMPSON,
Hon. Treasurer.

OFFICIAL LIST OF MEMBERS.

HONORARY MEMBERS.

1887 Bodington, Sir N., Litt.D., Vice-Chancellor, The University, Leeds.

1887 Hughes, Prof. T. McK., M.A., F.R.S., F.G.S., Ravensworth, Brooklands Avenue, Cambridge.

1887 Judd, Prof. Jno. W., C.B., LL.D., F.R.S., F.G.S., 30, Cumberland Road, Kew, Surrey.

1887 Woodward, Henry, LL.D., F.R.S., 13, Arundel Gardens, Notting Hill, London, W.

1907 Woodward, Arthur Smith, LL.D., F.R.S., F.L.S., British Museum (Natural History), S. Kensington, London, S.W.

1898 Whitaker, William, B.A., F.R.S., F.G.S., Freda, Campden Road, Croydon.

ORDINARY MEMBERS.

* Life Members who have compounded for the annual subscriptions.

Elected.

1883*Abbott, R. T. G., F.S.I., Whitley House, Malton.

1907*Ackroyd, Hy. Ed. P., Dean House, North Brierley, Bradford.

1903 Ackroyd, Wm., M.E., F.I.I., Nan Tan, Wortley, Leeds.

1901*Anderson, Tempest, M.D., F.G.S., 17, Stonegate, York.

1899 Appleyard, J. H. R., B.Sc., 5, Willow Lane East, Huddersfield.

1909 Appleyard, C. H., Calder Road, Hopton, Mirfield.

1908 Archer, J. Fletcher, B.A., M.I.Mech.E., 48, High Street, Doncaster.

1900 Ashley, Theodore, Pear Tree House, Loftus, Yorkshire.

1900 Ashworth, John Hoyle, Wood Rhydding, Ilkley.

1910 Baldwin, Harry, A.R.C.S., Department of Geology, The University, Leeds.

1879*Bartholomew, C. W., Blakesley Hall, near Towcester.

1909 Baxter, G. F., 39, Kenwood Park Road, Sheffield.

1878 Bedford, J. E., F.G.S., Arncliffe, Shire Oak Road, Headingley, Leeds.

1903 Beverley, Robert B., Heath House, Wakefield.

1895 Bingley, Godfrey, Thorniehurst, Shaw Lane, Headingley, Leeds.

1909 Bisat, W. S., Leighton Reservoir, Healey, Masham.

1907 Booth, Peter, 30, Mexborough Drive, Chapeltown Road, Leeds.

1876*Bowman, F. H., D.Sc., F.R.S.E., F.I.S., 181, Stamford Street, Brooks Bar, Manchester.

1907 Bradshaw, Chas., F.C.S., Public Museum, Weston Park, Sheffield.

1896 Bradley, F. L., Ingleside, Malvern Wells.

1894 Branson, F. W., F.I.C., F.C.S., 14, Commercial Street, Leeds.

1875*Brigg, John, M.P., F.G.S., Kildwick Hall, Keighley.

1909 Broadbent, Fredk. J., Croft House, Knowl, Mirfield.

1905 Brodrick, Harold, M.A., 7, Aughton Road, Birkdale, Lancs.

1907 Brooke-Fox, F. G., F.G.S., Townsend House, Halberton, Tiverton.

1907 Brown, T. E., Green Hill, Salterforth, Colne, Lancs.

1887 Brownridge, C., M.Inst.C.E., F.G.S., 21, Willowbank Road, Devonshire Park, Birkenhead.

1882*Buckley, George, Tower Chambers, Halifax.

1896 Burrell, B.A., F.I.C., F.C.S., 8, Springfield Mount, Leeds.

1904 Burton, Jos. J., Rosecroft, Nunthorpe, R.S.O.

1903 Carlton, John, 48, Albany Street, Hull.

1905 Carpenter, F. G., Somerleigh House, Pinderfields, Wakefield.

1900 Carr, Professor J. W., M.A., F.L.S., F.G.S., University College, Nottingham.

1909 Carruthers, R. G., B.Sc., H.M. Geological Survey, 33, George Square, Edinburgh.

1892*Carter, W. Lower, M.A., F.G.S., East London College, Mile End Road, London, E.

1876*Cash, W., F.G.S., 35, Commercial Street, Halifax.

1891*Chambers, J. C., Edgerton Road, West Park, Leeds.

1908 Chapman, E. H., 3, Hare Court, Temple, London, E.C.

1875*Charlesworth, J. B., J.P., Hurts Hall, Saxmundham.

1906 Cheetham, C. A., Nutting Grove, Farnley Leeds.

1892*Childe, Hy. Slade, F.G.S., Mining Engineer, Wakefield.

1903 Chippendale, Amos, Sindale House, Harrogate.

1877*Clark, J. E., B.A., B.Sc., Asgarth, Riddlestown Road, Purley, Surrey.

1875 Cole, Rev. E. Maule, M.A., F.G.S., Wetwang Vicarage, near York.

1889 Crewe, Earl of, Crewe Hall, Crewe.

1894*Crowther, Henry, F.R.M.S., Philosophical Hall, Leeds.

1904 Culpin, H., 7, St. Mary's Road, Doncaster.

1899 Dalzell, A. E., F.A.A., 29, Northgate, Halifax.

1909 Dalton, A. C., 22, Dunstall St., Scunthorpe, Lincolnshire.

1894*Davis, James Percy A., Old Bunting, Nqqueleni, *viâ* Umtata, Pondoland West, South Africa.

1908 Dickenson, J H. S., 100, Howard Road, Walkley, Sheffield.

1900*Dickons, J. Norton, 22, Park Drive, Heaton, Bradford.

1902 Dixon, Ed. Wilson, M.Inst.C.E., 1a, Cambridge Crescent, Harrogate.

1908 Dixon, Fred J., F.G.S., A.M.Inst.C.E., Waterworks Engineer's Office, Ashton-under-Lyne.

1886*Dobinson, Launcelot, Park View, Stanley, near Wakefield.

1909 Duchesne, H., Ashdown, Saffron Walden.

1906 Dulau & Co., 37, Soho Square, London, W.

1908 Durnford, H. St. John, M.Inst.C.E., 2, Sepulchre Gate, Doncaster.

1896 Dwerryhouse, Arthur R., D.Sc., F.G.S., Deraness, Deramore Park, Belfast.

1879 Eddy, J. Ray, F.G.S., Carleton Grange, Skipton.

1904 Edwards, E. J., M.Sc., University College of South Wales and Monmouthshire, Cardiff.

1908 Elgee, Frank, The Museum, Middlesbrough.

1894 Embleton, Henry C., Central Bank Chambers, Leeds.

1887*Fennell, Chas. W., F.G.S., 82, Westgate, Wakefield.

1902 Fitzwilliam, Earl, Wentworth Woodhouse, near Rotherham.

1883*Fleming, Francis, 75, Victoria Crescent, Eccles, Manchester.

1893 Forsyth, David, D.Sc., M.A., 101, Caledonian Road, Leeds.

1908 Foster, Harold T., B.Eng., M.I.M.E., 104, Coronation Villas, Bentley, Doncaster.

1904 Fowler, Rev. J. C., M.A., F.G.S., Whorlton Vicarage, Northallerton.

1894 Fox, C. E., P.A.S.I., 7, Rawson Street, Halifax.

1906 Frost, Rev. G. Percy H., M.A., Tanfield Rectory, Bedale.

1891*Furness, Sir Christopher, M.P., Brantford, West Hartlepool.

1890 Garforth, W. E., C.E., F.G.S., Snydale Hall, Pontefract.

1907 Gibson, Joseph, F.R.M.S., Elmfield, Psalter Lane, Sheffield.

1909 Gill, Edwin, Fold Head, Mirfield.

1907 Gilligan, Albert, B.Sc., The University, Leeds.

1881 Gleadow, F., 38, Ladbroke Grove, London, W.

1905 Grace, George, B.Sc., Holmlea, Infield Park, Barrow-in-Furness.

1905 Green, H. G. H., Claremont, Bradford Road, Wakefield.

1843 Halifax, Viscount, Hickleton Hall, Doncaster.

1906*Hargreaves, Walter, Rothwell Haigh, Leeds.

1895 Harker, Alfred, M.A., F.R.S., F.G.S., St. John's College, Cambridge.

1905 Hartley, R. J., A.M.Inst.C.E., Borough Waterworks Engineer, Halifax.

1909 Hartshorn, J., Leyburn, R.S.O., Yorkshire.

1887 Hastings, Geoffrey, 15, Oak Lane, Bradford.

1896 Hawkesworth, Edwin, Sunnyside, Crossgates, near Leeds.

1907 Highfield, E. G., B.Sc., 18, Hall Garth, Pickering.

1905 Hill, Charles Alexander, M.B., D.Ph., 13, Rodney Street, Liverpool.

1900*Hind, Wheelton, M.D., F.G.S., Roxeth House, Stoke-on-Trent.

1910 Hobson, Bernard, M.Sc., F.G.S., Thornton, Hallamgate Road, Sheffield.

1905 Hodges, Isaac, Whitwood, Normanton.

1881 Horne, Wm., F.G.S., Leyburn.

1890*Howarth, J. H., J.P., F.G.S., Somerley, Rawson Avenue, Halifax.

1907 Hummel, Ernest, B.Sc., c/o The University, Leeds.

1902*Ibbotson, John, Fitzalan Square, Sheffield.

1907 Ibbotson, William, 144, Burngreave Road, Sheffield.

1895*Imbery, John, Norfolk Mount, King Cross Street, Halifax.

1903*Ingham, Edward T., J.P., Blake Hall, Mirfield.

1910 Ives, Louis, Deputy City Surveyor, Town Hall, Wakefield.

1904 Johns, Cosmo, F.G.S., M.I.Mech.E., Burngrove, Pitsmoor Road, Sheffield.

1910 Johnson, Rev. W., B.A., B.Sc., Archbishop Holgate's School, York.

1905 Jones, Rev. E., Embsay.

1887*Jones, J. E., Solicitor, Halifax.

1897 Jowett, Albert, M.Sc., The Technical School, Bury.

1892 Kendall, Professor Percy F., M.Sc., F.G.S., Rose Dene, Weetwood, Leeds.

1902 Kidston, Robert, LL.D., F.R.S., F.R.S.E., F.G.S., 12, Clarendon Place, Stirling.

1897*Kitson, R. H., LL.D., F.G.S., Elmet Hall, Leeds.

1877*Lamplugh, G. W., F.R.S., F.G.S., 13, Beaconsfield Road, St. Albans.

1894 Law, Arthur W., Greetland, Halifax.

1903*Lawrence, J. P., A.M.I.C.E., Scriven, near Knaresborough.

1907 Lindley, W. E., Westfield, South Lane, Shortlands, Kent.

1906 Lofthouse, J. H., Lyell House, Dragon Parade, Harrogate.

1905 Longbottom, J. Leonard, Dingleside, Gledholt, Huddersfield.

1909 Lu, C. C., c/o The University, Sheffield.

1906 Lund, Percy, 57, Southfield Square, Manningham, Bradford.

1877*Lupton, Arnold, F.G.S., M.Inst.C.E., 7, Victoria Street, Westminster.

1905 Macturk, G. W. B., 15, Bowlalley Lane, Hull.

1908 McLaughlin, Hubert, W. C., Haverah Bank, Sedbergh, S.O.

1905 Milton, J. H., F.G.S., Harrison House, Crosby, Liverpool.

1896 Moreton, Henry James, Ship Hotel, Royston.

1879*Morrison, Walter, J.P., Malham Tarn, Settle.

1906 Mott, C. F., M.A., Giggleswick.

1894*Maufe, H. Brantwood, B.A., F.G.S., 33, George Square, Edinburgh.

1895 Muller, Harry, 12, West Park, Eltham, Kent.

1903 Naylor, E., Heather Bank, Hazelhurst Road, Bradford.

1902*Nettleton, Stanley, Roundwood, Ossett.

1898 Nevin, John, J.P., F.G.S., Littlemoor, Mirfield.

1889*Nicholson, M., J.P., Middleton Hall, near Leeds.

1899*Ormerod, William, Kershaw House, Luddendenfoot.

1875*Parke, G. H., F.G.S., F.L.S., Aysgarth, The Mall, Southgate, London, N.

1908 Parker, George, M.Inst.C.E., c/o H. C. Embleton, Esq., Central Bank Chambers, Leeds.

1910 Parsons, Ernest, B.Sc., 13, Colville Terrace, Beeston, Leeds.

1892*Pawson, A. H., F.L.S., F.G.S., Howe Combe, Watlington, Oxon.

1906 Phillips, John H., Tregolan, Bradford Place, Penarth, Glam.

1905 Pickles, Herbert, B.A., 5, Brudenell Mount, Hyde Park, Leeds.

1897 Pratt, Rev. Chas. T., M.A., Cawthorne Vicarage, near Barnsley.

1905 Punch, J. W. R., Hastoe House, Southfield Road, Middlesbrough.

1859*Ramsden, Sir J. W., Bart., Byram Hall, near Pontefract.

1904 Rastall, R. H., M.A., F.G.S., Christ's College, Cambridge.

1907 Ratcliffe, H. B., Tanfield Buildings, Hustler Gate, Bradford.

1864*Rhodes, John, Bolton Royd, Bradford.

1907*Robinson, John Gorges, B.A., J.P., Cragdale, Settle.

1898 Robinson, William, Greenbank, Sedbergh, R.S.O.

1901 Roebuck, W. Denison, F.L.S., 259, Hyde Park Road, Leeds.

1907 Roome, G. W., B.Sc., F.G.S., 214, Psalter Lane, Sheffield.

1903*Rowe, Arthur W., M.S., M.B., F.G.S., 1, Cecil Street, Margate.

1902 Rowland, Lewis G., Thwaitefield, Goathland.

1896*Rowley, Walter, F.G.S., F.S.A., 20, Park Row, Leeds.

1882 Scarborough Philosophical Society, The Museum, Scarborough.

1905 Sewell, J. T., Chubb Hill Road, Whitby.

1909 Shaw, H. Dixon, The Vicarage, Battyeford, Mirfield.

1897*Sheppard, Thomas, F.G.S., The Museum, Hull.

1906 Sibson, Ernest O. D., 36, Elton Parade, Darlington.

1892*Simpson, W., F.G.S., Catteral Hall, Settle.

1904*Simpson, J. T., J.P., Brackenholm, Rutland Road, Harrogate.

1887 Slater, M. B., F.L.S., 84, Newbiggin, Malton.

1876*Smith, F., Dunham Lawn, Bowden, Cheshire.

1875 STANHOPE, Sir WALTER SPENCER, K.C.B., Cannon Hall, Barnsley.

1881*STANSFELD, ALFRED W., Dacre House, Rock Ferry, Cheshire.

1900*STANSFIELD, W. G., 15, Apsley Crescent, Manningham, Bradford.

1890 STATHER, JOHN W., F.G.S., Brookside, Newland Park, Hull.

1898*STEWART, WILLIAM, Brooklyn, Crigglestone, Wakefield.

1885*STOCKDALE, T., Spring Lea, Leeds.

1902*STRINGER, G. E., Jun., Clayton West, nr. Huddersfield.

1894 SUTCLIFFE, J. W., The Hollies, Greenroyd, Halifax.

1888 SYKES, Sir TATTON, Bart., Sledmere House, near York.

1902*SYKES, ALFRED, Woodville, Thongs Bridge, Huddersfield.

1910 SYKES, RONALD, Woodville, Thongs Bridge, Huddersfield.

1897*TEAL, JOSEPH, Banksfield House, Yeadon, near Leeds.

1894 TETLEY, ED. H., B.A., 18, Moorland Road, Leeds.

1880 TETLEY, C. F., M.A., Spring Road, Headingley, Leeds.

1886 THOMPSON, R., Dringcote, The Mount, York.

1902 THOMPSON, Professor G. R., B.Sc., The University, Leeds.

1908 THORNBER, W., Oxford Chambers, Victoria Square, Leeds.

1910 TICKLE, GILBERT, Y., H.M. Inspector of Mines, 307, Fulwood Road, Sheffield.

1875*TIDDEMAN, R. H., M.A., F.G.S., 175, Banbury Road, Oxford.

1907 TIFFANY, F., B.Sc., Engineer's Office, Midland Railway, Derby.

1904 TOWNEND, GEORGE F., Pleasant View, Earby, Colne, Lancs.

1899*TURTON, ROBERT B., Kildale Hall, Grosmount, Yorks, R.S.O.

1905 VEITCH, W. Y., L.R.C.P., L.R.C.S., F.G.S., 6, Southfield Villas, Middlesbrough.

1905*VICKERS, T. E., C.B., M.Inst.C.E., M.I.Mech.E., River Don Works, Sheffield.

1905 WADSWORTH, Rev. H., F.R.M.S., The Grange, Wadsley Bridge, Sheffield.

1907 WAGER, MORTON E., B.Sc. (Lond.), Cragg Road, Mytholmroyd, Yorks.

1910 WALKER, JOSEPH, Wooldale, Thongs Bridge, Huddersfield.

1905 WALKER, W. P., Mineral Valuer, Valuation Offices, Manor Row, Bradford.

1884*Walmsley, A. T., M.Inst.C.E., F.S.I., F.K.C., Engineer to the Dover Harbour Board, 9, Victoria Street, London, S.W.

1894 Walton, F. Fielder, F.G.S., L.R.C.P., 19, Charlotte Street, Hull.

1875*Ward, J. Whiteley, J.P., F.R.M.S., Brinkworth Hall, near York.

1898 Wellburn, Edgar D., L.R.C.P.E., F.G.S., Beech House, Sowerby Bridge.

1906 Wells, George John, 14, Bannerdale Road, Sheffield.

1900 Wharncliffe, Earl of, Wortley Hall, Sheffield.

1889 Wilkinson, J. J., Burnside, Skipton.

1906 Willey, Edward, B.Sc., A.M.Inst.C.E., Workington Iron and Steel Co., Ltd., Shimoga, Mysore State, India.

1894 Williams, W. Clement, F.R.I.B.A., Corn Market, Halifax.

1909 Wills, Albert E., Denby Villas, Knowl Road, Mirfield.

1905 Wilmore, Albert, D.Sc., F.G.S., Fernbank, Colne, Lancs.

1894 Wilson, J. E., F.G.S., Dunholm, Ilkley.

1897 Wilson, J. Mitchell, M.D., County Hall, Beverley.

1906 Wilson, J. R. R., M.Inst.C.E., Chief Inspector of Mines in India, 9, Dacres Lane, Calcutta.

1909 Wilson, R. B., Fell Grove, Ben Rhydding, *viâ* Leeds

1909 Wilson, G. V., Arthington Road, Pool, Leeds.

1909 Wroot, H. E., 45, Pollard Lane, Bradford.

⁂ It is requested that any Member changing his residence will communicate at once with the Hon. Secretaries.

Vol. XVII.] [Part III.

PROCEEDINGS

OF THE

YORKSHIRE GEOLOGICAL SOCIETY.

Edited by W. LOWER CARTER, M.A., F.G.S.

1911.

ADDRESS BY THE PRESIDENT,

PROFESSOR PERCY FRY KENDALL, M.SC., F.G.S.,

HON. MEM. INST. MINING ENGINEERS.

(Delivered November 3rd, 1910).

The death of our much-lamented President, the late Marquis of Ripon, cast upon the Society the necessity for revising the policy by which it had been guided in the past, and in view of the improbability of obtaining another President combining as he did a generous and life-long love of our Science with the distinguished attainments of a statesman and man of affairs, it has been resolved that for the future the dignity should be conferred upon men whose qualifications are based solely upon their devotion to the study of Geology and their activity in the field of geological enquiry, especially in our own county.

The first duty that devolves upon me is the painful one of reciting some of the losses sustained by the Society during the past year.

We have lost several members by death, among whom three stand pre-eminent by their services to Yorkshire Geology.

The Marquis of Ripon, K.G., for 52 years President of the Society, was a real lover of our science and not only manifested a keen interest in our work down to the end of his life, but attended our meetings whenever the onerous responsibilities of his busy life permitted it ; he presided at the first meeting of the Society that it was my good fortune to attend. A memoir from the pen of Mr. Lower Carter has already appeared in our Transactions, and I may be allowed to say that to those who were privileged to meet Lord Ripon it is not difficult to understand that his sympathetic administration of the great dependency of India will live long in the grateful recollection of our distant fellow-subjects.

Charles Fox-Strangways rendered services to Yorkshire Geology that it would be hard to over-estimate. His labours on the Geological Survey, from which he retired but a short time before his death, were, in great part, in this county, partly in the country about Harrogate, and, more particularly, in the Jurassic regions of the North and East Ridings. Besides most notable revisions of the Jurassic series, he gave us a complete conspectus and codification of the entire sequence of Liassic and Oolitic rocks. His contributions to the study of the Physical Geography of the regions mapped by him furnish an admirable basis for future work, and, of the beauty and accuracy of the maps prepared by him, it would be hard to speak in terms of overpraise. I feel a strong sense of personal indebtedness to Strangways for maps that have formed the starting point of much of my own work, and that have never, in a single instance needed rectification, even though my surveys have been assisted by records of borings and cuttings not available at the time of the original survey.

John Roche Daykns, whose death at the age of 74 was reported a few weeks ago, laboured long upon the official Geological Survey of Yorkshire, especially in the West and North Ridings, and though, upon his retirement from the service, he withdrew to the solitudes of Snowdonia, his interest in Yorkshire and this Society never relaxed. He contributed several valuable papers to our Proceedings, distinguished by the characteristics of all his work, careful and exact observations and sagacious reasoning. His papers on the Glacial Phenomena of Wharfedale may well be taken as models of temperate statement and judicious inference. The admirable spirit of impartiality displayed by his contribution to the discussion of the origin of Reef-knolls is worthy of all praise.

The Society loses in him an earnest friend and well wisher, and a member of over 30 years' standing. His name is still held in affectionate remembrance in many lonely hill farmhouses, where he made his home while surveying the highest hills of the Yorkshire Pennines.

Turning now to the topic upon which I have more particularly to address you. It seemed to me appropriate that as my immediate predecessor had occupied this chair for more than half a century, I should devote myself to a brief review of the progress made by Geology, especially in Yorkshire, during his long tenure of office, and I may here parenthetically remark upon the striking circumstance that this, the oldest Geological Society in the Kingdom, save three, has had but two Presidents in the 76 years of its existence.

Lord Ripon was elected President on the 8th December, 1858.

The sixth decade of the Nineteenth Century found British Geology well-established upon a firm basis. In the first flush of its youth, it had sown its wild oats and a rare crop of unsound hypotheses was springing up, but the healthy chill of criticism administered by the brilliant band of the new Huttonians, foremost amongst whom stood Lyell, cut down the weeds and gave vigour to a sounder growth.

Lyell's Uniformitarian doctrine had won almost universal acceptance though only after a severe struggle with the catastrophic school that long had held the field—even the great and broad-minded Sedgwick had made a strenuous attack upon Lyell's Principles from the Presidential chair of the Geological Society in 1829, but in 1859 he was as convinced a Lyellian as anyone, and Catastrophism was making its last stand at the Diluvial hypothesis.

William Smith's great principle that strata could be identified by their fossils had, by dint of mere reiteration, forced itself upon the attention of geologists and had now passed into a commonplace. It had, too, been further refined by the recognition of zonal successions in the great homogeneous formations, the Lias being the subject of the first essay. This work, well begun by Oppel, Quenstedt and other continental geologists, was finding new applications in England.

It was a great advance, and it led to great extensions of the knowledge of the Lias of Yorkshire.

Stratigraphical Geology had made such strides that no new formation has been discovered since 1859. Everything from the Cambrian to the Alluvium was known, and had been placed in its proper sequence. An immense impetus had been given to this branch by the foundation of the Geological Survey, at first in a tentative form, when it was decided to employ certain gentlemen to colour Ordnance Maps with an indication of the Geology, that was how their function was described, and Sir Henry de la Beche was given the direction of the work. From then till now it has passed under the control of a great variety of Government departments, and the Board of Agriculture is at present the over-ruling authority. The Survey of Yorkshire had not been begun in 1859, which was perhaps a fortunate circumstance, as the surveyors would not at that time have had the inestimable advantage of the splendid six-inch maps contoured for every twenty-five feet of height, that this favoured county now enjoys along with Lancashire.

To the Yorkshire geologist of to-day these maps and the accurate and detailed mapping of the Geological Survey are as daily bread, and none realises more fully than myself how great a part they have played in stimulating and aiding original research. The country has reason to be proud of the unrivalled achievements of a branch of the public service that receives very inadequate support from the Treasury, and we in Yorkshire may congratulate ourselves upon the possession of some of its finest products.

Descriptive and systematic Palæontology was already secured from neglect by the foundation of the Palæontographical Society, that year by year from 1848 has published magnificent monographs on British fossils, and its valuable activity still continues.

The Geological Survey made some effort in the same direction by the publication of its admirable and beautifully illustrated Decades. This work was, unhappily, discontinued, but not before the genius of Edward Forbes and of Huxley had produced monographs on groups of fossils of great interest.

Dr. Peach's recent memoir on the Higher Crustacea of the Carboniferous Rocks is a welcome assurance that the palæontological knowledge of the members of the Survey is not to be allowed to be lost.

Within less than a year of the accession of the Marquis of Ripon, two momentous papers appeared, inequal in magnitude, but one destined to effect a revolution in a great field of Geological enquiry, the other to profoundly affect almost every field of thought and enquiry, and Geology not less than others.

The first of these, published less than a month before the Marquis of Ripon's assumption of office, was Sorby's epoch-making paper, presented to the Geological Society, on the microscopic structures of crystals and their application to the determination of the origin of minerals and rocks. Sorby had already demonstrated the value of thin sections in the study of rock structures in aqueous rocks, but in this famous memoir the whole modern study of Petrology may be said to have had its birth.

The second paper in order of time was Darwin's outline of his theory of Evolution in the organic world, presented to the Linnean Society in July, 1858, and followed in the autumn of the same year by the publication of the "Origin of Species." It is of interest to geologists to recall that Darwin had, up to that time, been regarded as primarily a geologist, and John Phillips, in presenting to him the Wollaston Medal, conferred by the Geological Society in February, 1859, referred especially to his researches upon Glacial Geology and Coral Reefs, and, finally, to his Monograph on the Cirripedia as "the rarest acquirements of a naturalist with the qualifications of a first-class geologist."

The "Origin of Species" aroused instant interest as may be judged by the fact that the first issue of 1,250 copies was sold out in a single day, and the feelings aroused, whether hostile or friendly, had the effect of giving an incalculable impulse to the study of all branches of Natural Science.

Impelled by such a momentum on both its biological, and its physical side, our science entered upon that half century of progress that I shall endeavour very broadly to trace.

Let us look first at Stratigraphical Geology.

The whole of England has been mapped by the official Geological Survey, the Coalfields and much of the Yorkshire Coast on the six-inch scale, and in this work, or aided by the maps, the great formations have been divided into smaller sub-divisions, and these in many cases into smaller still, so that, like the "Green Streak," in our Silurian rocks, even a layer an inch in thickness, if a significant inch, is not disregarded. The last work that Sorby published—written, or dictated, when he was lying upon his death-bed—was an attempt to show the time-equivalent of an inch of sediment.

We have come to see that deposits may be laid down very rapidly in one place, and very slowly in another, so that an inch of Red Clay or Radiolarian Ooze might represent a period of continuous deposition that found expression elsewhere in a thousand feet of shallow water deposit.

In Stratigraphical Palæontology the principles of Zoning have been applied with extraordinary success.

The first piece of minute zoning accomplished in Britain was in the Lias. The principles were quickly applied in Yorkshire, but the major part of the work had already been done in the Cotswolds, and in that splendid work of Judd's the Geology of Rutland. Then, following the Lias, the Oolites were zoned, and, at a long interval, it was discovered that the Chalk was also amenable to the zonal method. Mr. Caleb Evans, working along a derelict railway near Croydon, found that the Southern Chalk was separable into fairly well-defined horizons by distinctive fossils, such as Brachiopods, Lamellibranchs, Cephalopods, and Echinoderms. It was my good fortune as a young man to be sent to trace these zones on the same line of section and my first published paper resulted from observations then made.

The zoning of the Chalk was a very important achievement, as the lithology varies from place to place, and the lithological characters cross over from Upper to Middle and *vice-versa* in a manner that defies analysis without the aid of the fossils. Our

Yorkshire Chalk was brought into harmony with the southern developments by Dr. Barrois with greater success than has been commonly supposed. Our own members, Lamplugh and Stather, have greatly aided in the work, and, finally, Dr. Rowe having mastered with admirable skill the coast exposures in the South, has given us a very full and satisfactory, if not exhaustive, description of the developments of the Chalk at Flamborough.

The Speeton Clay was zoned by Judd soon after the date of his Rutland Memoir, and his work has been revised in later years by Lamplugh, whose researches were prosecuted under conditions and at times that would have deterred any but the most hardy and determined of workers.

Mr. Lamplugh has shown that these beds lying between the Kimeridge Clay and the Red Chalk constitute a marine series whose equivalents in the South of England are mainly of fresh-water origin—he subdivides them into a series of zones based principally upon the Belemnite fauna. He finds the closest analogies are between these beds and deposits of the same age in Heligoland and Russia.

The Jurassic rocks have been diligently studied by a host of able men among whom must be signalised Hudleston, Blake, Barrow and Fox-Strangways, and, while much may still be done to complete the correlation with southern developments of the series and to increase our knowledge of the physical conditions under which they were deposited, it is unlikely that much rectification, if any, of the stratigraphy will be found necessary.

Of the Triassic rocks little more is known than was known to the geologists of fifty years ago, except that a few borings, *e.g.*, at Barlow and near the mouth of the Tees enable us to assign a definite thickness to the sandstones that form the lower member of the series.

The Permian rocks have yielded a rather larger collection of new facts, and explorations for coal at the mouth of the Tees, and at Barlow, reveal the occurrence of a series of marls and marly sandstones above the Magnesian Limestone forming, apparently, a perfect transition from the Permian up into the Trias. The marls contain much gypsum and anhydrite, and in both areas rock salt has been discovered.

The Carboniferous series, first among the rocks of Yorkshire in economic importance as well as in area of outcrop, have also yielded the largest series of new observations and speculations.

The Coal Measures have been mapped by Green and others, and one of the weightiest and most detailed of the memoirs of the Geological Survey is that upon the Yorkshire Coalfield by Green. It is a wonderful monument of industry and care, and a mine itself of valuable, if rather indigestible facts. As a lucid and fascinating exposition of Coal Measure Geology, however, Green's contribution to the book on Coal by the professors at the Yorkshire College stands without a peer.

The Palæontology of the Yorkshire Coal Measures is far more thoroughly known and studied now than at the time with which this retrospect begins.

The air-breathing Vertebrates have been studied by Miall, and the Fishes have been the subject of memoirs almost innumerable by that giant of industry, our late Secretary, J. W. Davis. The work is being carried on by Dr. Wellburn. The Invertebrates have been, and are being, minutely studied by Dr. Wheelton Hind, and the distribution of bands characterised by a marine fauna, now of such value and significance in the exploration of the concealed part of the coalfield, are known mainly or almost entirely by the self-denying labours of Mr. Culpin; but it is right that I should mention the most admirable work that has been done at Maltby by Mr. W. Dyson.

The structure of the plants of the Coal Measures has been studied by a host of botanists, the pioneers, however, were Williamson, Spencer, Hick, and last, but not least, our old and valued member, Mr. William Cash, one of the ardent and generous spirits who for so many years made Halifax the true centre of scientific life in Yorkshire.

The study of the Coal Measure Flora and its vertical distribution has made great progress, though much still remains to be done. Assiduous collectors like W. Hemingway, of Barnsley, and John Bond, of Leeds, have made gatherings from specific horizons in the Coal Measures, and their materials have been identified by Dr. Kidston and other systematists, whereby our knowledge has been much enlarged.

The Millstone Grit has by no means escaped attention, even though the shattered state of the country and the rarity of good land marks in the series have rendered the study one of considerable difficulty. Tute's work on the Cayton Gill beds has added much to our knowledge of the fauna besides giving a new datum in the stratigraphy ; and the discovery of a great fauna in the shales of Eccup and Mr. G. V. Wilson's researches in Wharfedale have shown that the shales, if not mainly of marine origin, certainly contain many important marine beds.

The Yoredale Rocks, and more particularly, the Pendleside series that some geologists consider to be contemporary with them, as they admittedly are homotaxial, have been studied by Tiddeman, Hind, Howe and Johns.

The Carboniferous Limestone exacted very close and careful attention from Prof. Hughes and his colleagues on the Geological Survey, but though very diligently studied, no striking new facts in Palæontology were discovered. The late Prof. Lohest attempted a general correlation with the series on the Meuse, but nothing like a definite zonal classification was practicable. Some twelve years ago, however, a young geologist, well-known in this Society, was seeking a subject for original research to be prosecuted under the tenure of a University Scholarship : on my advice, he offered what to me was a very promising theme—the zonal study of the Carboniferous Limestone. It seemed to me that there could be no more favourable field for such an enterprise than our Yorkshire Dales where these rocks yield magnificent exposures as every one here knows.

The proposition was submitted to the authorities, but was rejected on the apparently adequate ground that the Carboniferous Limestone was one and indivisible from top to bottom, and therefore that any attempt to zone it was foredoomed to failure. Had the Committee displayed a more sanguine and less conservative spirit, who knows but that instead of an " Avonian " sequence, the type might have been the " *Cravenian*." It is no use indulging in vain regrets, and we may be unreservedly thankful that a genius arose in the south to give us the clues that we wanted. Dr. Arthur Vaughan, working in the Bristol area, found that the Carboniferous Limestone could be zoned, but on a different principle from that applied to other cases.

He found that he could trace the evolution during Lower Carboniferous times of both species and genera, and that even varietal changes were, to a discerning eye, sufficient for zonal purposes. I must not take up your time with an attempt to interpret his remarkable results, but I may say that they were in substantial agreement with views entertained, but, unfortunately, not adequately published, long before by Prof. Garwood.

Mr. Johns has taken up the subject with characteristic zeal and enthusiasm, and has shown us on several occasions how the Avonian succession, or rather the upper part of it, is traceable in Yorkshire. Dr. Wilmore, also, has dealt in a very thorough manner with the area round the middle course of the Ribble, and has devoted much care to the study of the microscopic characters of the Limestone.

Some physical problems concerning the mode of and conditions of accumulation of masses of highly fossiliferous limestone have been discussed by Mr. Tiddeman, whose ingenious and attractive theory of Reef-knolls has been much discussed at our meetings without evoking any decisive consensus of opinion. At the same time, however, it has furnished a valuable provocation to those vigorous and frank discussions that contribute largely to the hearty camaraderie for which geologists are renowned.

Another and much larger problem is concerned with the form and magnitude of the Eastern extension of the Yorkshire Coalfield.

Two Royal Commissions have successively attempted its solution. The first had evidence before it by Professors Hull, Green and Ramsay, as well as from geologists of lesser rank, and alternative lines of limitation were adopted, each indicating a generous reserve of untouched coal. No very definite principle was enunciated to guide the Commission, though one witness, a mathematician, offered a mathematical treatment of the problem, the substance of which appeared to be that, as the exposed field was roughly half an ellipse having the edge of the Permian rocks for its major axis, it should be assumed that this was half the coalfield, and by completing the ellipse, we should have an approximate eastern boundary of the coalfield defined. This sounds very like the old gibe at the mathematical solution of earlier and more intricate geological problems—guess half and multiply by two.

The 1901-5 Commission (Lord Allerton's) accepted as regards the northern and eastern boundaries a principle well recognised by students of Geological Tectonics, that folds of the strata have frequently manifested a tendency to accentuate from time to time by successive movements, at intervals represented by whole geological periods, and in some cases by frequent repetitions of the folding movement operating during the formation of successive strata. Folding of both types were found to have occurred at Market Weighton on a line that seemed to be the easterly continuation of the northern edge of the coalfield. The southern limit seemed to be indicated by a broad zone extending from Charnwood to near Cambridge. The eastern boundary might possibly be found on the line of a post-Cretaceous fold running through Louth.

These principles were accepted by the Commissioners, who, however, did not adopt the southern boundary suggested and proposed themselves one running from Charnwood to the Wash.

Even thus limited, the hidden coalfield is of majestic dimensions, and must constitute the greatest of the national coal assets.

The older Primary rocks have been studied in detail by Prof. Hughes and others on behalf of the Geological Survey, and Dr. Marr and some of the later generation of geologists from Cambridge have added largely to our knowledge of these rocks, in which Lapworth's Graptolite Zones have been recognised.

A notable result has been the recognition by Mr. Rastall of an Archæan series in Ribblesdale and Chapel-le-Dale. Aveling, when mapping in the district thirty years before, had pointed out the resemblance of the grits and slates under Ingleborough to the rocks of the Longmynd, and his observations are confirmed by Mr. Rastall, who proposes to call this series the Ingletonian.

Many interesting tectonic problems relating to the upbuilding of Yorkshire have engaged the attention of geologists especially during the last twenty years. Most of these relate to the rôle of the Craven faults and the folds related to them. John Phillips drew attention to them in his classical Geology of Yorkshire, and they have been discussed by Marr and myself on several occasions, but the conclusions reached will probably need much revision.

Out of Sorby's researches into the microscopic structure of minerals and rocks has grown the great and progressive science of Petrology, a branch of Geology that has developed methods of extraordinary refinement and precision. A pebble a quarter of an inch in diameter may now be sliced and submitted to an optical analysis that will not only disclose its mineral constituents and structure, but will reveal its mode and place of origin and the vicissitudes through which it has passed. The subject is too gigantic to be more than hinted at here, but it may be observed that the study of this branch of Geology supplies just that element of exactitude and precise measurement, the assumed absence of which has often been made matter of reproach by the cultivators of the physical sciences.

It may suffice to say that the Petrological study of the rocks of Yorkshire has been prosecuted with success by Sorby himself, as well as by many of his successors.

There is one topic which, dangerous as it is, I can hardly venture to ignore since members of this Society have had a large share in its discussion. This is the important matter of Glacial Geology.

In the early part of the Nineteenth Century, the opinion was universally held by geologists that the tumultuous accumulations of rock-debris that we call collectively Drift, were the products of the Noachian Deluge, and hence these deposits were called, and still are so designated on the Continent, Diluvium. Having settled this point, the chief business of the early geologists was to discover the mechanical agencies by which this catastrophe was brought about.

Murchison and other geologists of the mid-Victorian age invoked great "waves of translation" sweeping out from the mountains and hurling boulders and all the rest of the Diluvial materials before them like dust before the broom.

Whewell was for a similar heroic treatment, and would heave up mountain massifs, such as the Scandinavian chain, with a few vigorous strokes, and in the best manner of his kind, having determined by a formula what magnitude of waves would propel rocks of given dimensions, and what displacement of mountains would produce such waves, continues "And thus, the great "mass of the Northern drift, inasmuch as no considerable part of "its transfer can be accounted for by any minute causes or languid "operations of water, is an irresistible evidence of paroxysmal "action; and of a scale which may be judged from the conclusion "at which we have arrived :—an elevation of 45,000 square miles "of sea-bottom through 500 feet." With great self-restraint he omits to add "Q.E.D."

The cataclysmal origin of the Drift furnished the principal argument advanced by Sedgwick against the "long way in a long while" uniformitarian doctrines of Lyell.

This, the last of the catastrophes, has made a strenuous struggle for existence and, when the Diluvial theory was reluctantly abandoned in favour of ice-action of some kind, its upholders compromised the matter by invoking a Great Submergence that would bring ice-bergs freighted with boulders from distant sources floating over the Pennine Chain and other hill regions. This hypothesis, while making liberal provision for the area of marine deposition, was parsimonious to a fault in the matter of breeding grounds for the glaciers ; however, in 1858, the Great Submergence was a compromise acceptable to all except a few stalwarts like Murchison who stood out for the old tradition.

Sir Archibald Geikie, in 1864, published a most notable contribution on Glacial Geology to the Glasgow Geological Society, in which he set forth with the clearness and precision that characterise all his writings a weighty, and one would have thought irresistible, array of facts and arguments in support of his contention that land ice had been the agent operative in the Lowlands.

The first serious blow struck in England at the submergence was, I am gratified to think, administered in 1872 by Mr. Tiddeman in his famous paper on the "Evidences for Ice-sheet in North Lancashire and adjacent parts of Yorkshire and Westmoreland." This was followed two years later by an equally admirable paper by Goodchild in which, dealing with an area slightly overlapping that dealt with by Mr. Tiddeman, he showed that the whole of the glacial phenomena could be ascribed to the action of land ice.

For several more years the new views made but little progress, the next light however came from the far West. In 1886 and 1887 Carvill Lewis came to this country to ascertain whether the principles that had served to explain the Glacial phenomena of N. America were not equally applicable to this country.

His work was characterised by great haste, and over wide areas his observations, often made from the windows of railway carriages, were very superficial, but, such as they were, they confirmed his first impressions based upon the general similarity between the American and the British phenomena. What, however, gave him an immense advantage in the discussion that ensued when he brought his views before the British Association was that he was, I believe, the first geologist who ever attempted to master the whole body of British Glacial literature (I am not prepared to say that there has been a fourth and perhaps not a third). With this wide reading and a personal examination of an immense tract of country he could treat the subject on an adequate scale, and not as a matter of parishes. The charm of a peculiarly gracious manner, added to all these other advantages, secured him a sympathetic hearing, and he made a few converts, who after the lamented death of this brilliant pioneer carried on the propaganda, and while, no doubt, helping the cause by the new facts they brought to light, and the temerity with which they assailed the old doctrine, cannot, I fear, be acquitted of the zeal that outruns discretion. For the next ten or twelve years, the British Association meetings were enlivened by debates in which downright hard-hitting was freely indulged on both sides, but gradually these lost their piquancy as one after another the "submergers" succumbed.

The chief bone of contention had been the occurrence of fragmentary and a few whole shells in the Drift. One side contended that these were indubitable proofs of marine deposition, while the other urged that, if a glacier or ice-sheet moved across a portion of the sea floor, shells in a more or less fragmentary condition might be dragged forward involved in the sub-glacial ground moraine. *A priori* arguments were advanced against the *possibility* of shells surviving this treatment, and the land-ice men were invited to answer the question "Then, can a glacier walk uphill ?"

They were challenged to cite any modern illustration of a glacier carrying shells, to which the only reply given was that such things could not be expected save in the Arctic regions, but that when a glacier could be caught in the act of crossing the sea-floor it would perhaps be found to transport shells. The logic of this reply is far from perfect, but it has been fully justified by the observations in Spitsbergen of the Swedish Geologists, of which Mr. Lamplugh promises us a full account corroborated by his own observations.

On this part of the issue, therefore, the land-ice theory claims the verdict.

Other aspects of the Glacial question have received illumination from the study of streamless valleys in this county, and, later, in many other parts of the British Isles. All observers who have investigated these phenomena in the field assent to the interpretation offered of the Yorkshire examples that they are the overflow channels of lakes held up by the margins of glaciers and ice-sheets, of whose positions they afford new and interesting proofs. The Geological Survey has explicitly adopted this explanation, and almost every recent memoir on a glaciated region contains references to these phenomena.

It was hoped that the old controversies had quite died out, and that the supporters of the Great Submergence were either converted or at least silenced, and it was therefore with a real and deep regret that we saw a year ago one of the most prominent of them blowing up the embers of a burnt down controversy.

It must not be supposed from this summary of achievements in every department of Geology that nothing remains for the rising generation of Geologists in Yorkshire to discover in the county. The vista widens as we approach it, and every new avenue of research discloses larger and yet larger prospects. Who is there that reads anew his " exhaustive " paper of ten years ago, but finds to his dismay that he had touched but the fringe of the subject ? Some of us have even found the subject of an apparently completed research so to grow under the pen that the pen has been laid aside for the hammer and a few more years of field work. There is no finality, and all writing is premature ; this is the feeling that often overcomes the geologist in his pessimistic or lethargic moods, but with renewal of energy, in optimistic spirit, he declares that " much has been done, but more remains to do." Let us up and do our part.

THE LOWER OOLITIC ROCKS OF YORKSHIRE.

BY LINSDALL RICHARDSON, F.R.S.E., F.L.S., F.G.S.

(Plates XXII.—XXIV.)

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I. INTRODUCTION.

In the summer of 1908 Mr. E. T. Paris and I spent some time visiting the principal sections of the Lower Oolites of Yorkshire with a view to seeing if it were possible to correlate these beds any more precisely than had already been done with those of the same series in the south-west of England. After my return, Mr. R. S. Herries very kindly lent me all the echinoids, brachiopods, and ammonites that he had collected from the Yorkshire Lower Oolites, and while Mr. Paris has named the echinoids, Mr. S. S. Buckman has identified the ammonites and has most kindly contributed two appendices to the present paper—the one descriptive of some ammonites from the Scarborough Limestone, the other comparing the uppermost Upper-Lias deposits in Yorkshire and the Cotteswolds.

In Yorkshire the beds that intervene *between the Cornbrash and the Upper Lias Clay* are mainly sandstones and shales of estuarine origin, but with four marine bands, whose upper and lower limits are ofttimes none too well defined. They are :—

[Cornbrash.]
(1) The Scarborough Limestone.
(2) The Millepore Limestone.
(3) The Eller-Beck Bed, and
(4) The Dogger.
[The Blea-Wyke Beds.]

In Table I. will be found detailed the principal sub-divisions that have been made of the Yorkshire Lower Oolites.

Table I.—Sequence of the Lower Oolitic Rocks of the Yorkshire Coast.

Lower Oolites.

Cornbrash.

(1) Shales, dark-coloured : a few feet thick at the Wyke, 6 to 8 feet thick in Newton Dale.

(2) Limestone, dark, full of fossils (see below), passing down into .. .. (3) Shales, impure, calcareous ..	1 to 2 ft. at the Wyke	More compact in Newton Dale and 7 to 8 ft. thick.

**Ornithella lagenalis* (Schloth.), **O. obovata* (Sow.) and the varieties called " *stiltonensis* " and " *siddingtonensis* " by Walker.
Rhyn. leedsi Walker,* *Echinobrissus orbicularis* Phil.,* *Holectypus depressus* (Leske), *Pleurotomaria granulata* (Sow.).
Cucullaea clathrata Leckenby,* *Goniomya litterata* (Sow.) Phil.,* *Lima rigidula* Phil., *L. helvetica* Oppel, *Protocardia citrinoidea* (Phil.), *Homomya crassiuscula* M. and L., **Trigonia scarburgensis* Lyc., *T. elongata* (Sow.),* *Isocardia nitida* Phil.,*
Alectryonia sp., *Pleuromya securiformis* (Phil.),* *P. decurtata* (Phil.),* *Serpula intestinalis* Phil., *S. tetragona* Sow., *S.* " *sulcata* Sow.," etc.

Yorkshire Estuarine Series.

		Approximate thicknesses in feet of the beds in the cliff-sections. (*after Jukes-Browne).
Upper Estuarines.	Thin beds of sandstone or quartzite and shale resting on extremely irregularly bedded sandstones and these on THE MOOR GRIT	120 to 200*
Scarborough Beds (*blagdeni* and *sauzei*).	These beds are usually divisible into three portions : (*a*) In which shales predominate : *Belemnites ellipticus* Miller ; (*b*) In which the arenaceous element preponderates and is often a grit rich in isocrinoid ossicles—CRINOID GRIT ; and (*c*) That in which limestones are most in evidence : *Gervillia scarburgensis* Paris	20 to 90*
Middle Estuarines (*? witchelliæ-shirbuirniæ*)	Sandstones, sandy shales and thin coal-seams. Rich " *plant-bed* " at Gristhorpe Bay	50 to 100*
Millepore Bed (*? discitæ*)	Limestone, hard, and ferruginous in places on the coast, at other arenaceous, and at WHITWELL and CAVE a thick " oolite " : *Spiropora straminea* (Phil.), etc.	20 to 40*
Lower Estuarines (*? concavi-bradfordensis*)	Sandy beds with massive sandstones in their lower portion and a marine band called the " ELLER-BECK BED "	200 to 280*
Dogger (*murchisonæ* and *? scissi*).	The NERINÆA-BED and associated deposits or Dogger	11½

NON-SEQUENCE.

UPPER LIAS.	Blea-Wyke Beds.	Yellow Beds (*dumortieriæ*)	Sandstones with pebbles at certain horizons, and numerous specimens of *Terebratula trilineata* auctt...	53
		Grey Beds (*dispansi*)	(*a*) SERPULA-BEDS	10¾
			(*b*) LINGULA-BEDS	32
	STRIATULUS-SHALES.		The top-portion may be of *dispansi* and *struckmanni* date, but the bulk is of *striatuli* : 50 to 70 feet	60

Many geologists have written on the deposits and an excellent summary of all that had been published up to and inclusive of the year 1892, together with additional information, is given in the Geological Survey Memoir on "The Jurassic Rocks of Britain," Vol. I. (1892), "Yorkshire," by the late C. Fox-Strangways.

It appears to have been realized for some time that the Blea-Wyke Beds correspond in a general way to the Sands and Cephalopod-Bed of the Cotteswolds ; that the Dogger is equivalent to the Pea-Grit Series of those hills ; and the Scarborough Limestone to the top-portion of the Inferior Oolite or thereabouts. But the matter that principally claimed the attention of previous workers was not, however, so much that of correlation as that of settling the question where precisely the line of demarcation between the Lias and Oolites should be drawn at Blea Wyke. Some workers placed the whole of the Blea-Wyke Beds in the Lias ; others in the Oolites ; while yet others parted them between the two.

Since the memoir referred to above was published in 1892, several other contributions have been made that require brief notice here.

The first was made in 1905, when Mr. R. H. Rastall wrote on "The Blea-Wyke Beds and the Dogger in North-East Yorkshire."[1] In it, he emphasizes the point that "a perfectly-complete transition from the Lias to the Lower Estuarine Series is seen only at Blea Wyke." He attributes the preservation of the beds that afford the "perfectly-complete transition," to movement along the Peak fault, whereby a cliff was produced on one side, up against which the Blea-Wyke Beds were accumulated.

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[1] Quart. Journ. Geol. Soc., Vol. LXI. (1905), pp. 441-457.

Mr. Herries, writing in the following year, that is, in 1906, found this theory " difficult to accept," and was inclined to think that deposit was made fairly regularly over the whole of this part of Yorkshire until the lower portion of the *Striatulus*-Shales had been laid down ; but that then there was movement along the Peak fault, and whilst deposit was continuous on the depressed side of the fault, in other parts some erosion contemporaneously proceeded. Then the Dogger was laid down during a general, but by no means uniform, subsidence.[1]

In November, 1909, I gave a lecture to the Ashmolean Society of Oxfordshire, and a summary was published in the " Report " for the year (*loc. cit.*, pp. 32-40).

In February, 1910, Mr. S. S. Buckman published a paper on " Certain Jurassic (Lias-Oolite) Strata of South Dorset and their Correlation," in which he forwarded matters by dating the *Lingula*-Bed portion of the Grey Beds as *dumortieriæ-dispansi*. This he did mainly on the evidence of some fragments of ammonites collected by me *in situ*, and it enabled him to state that the deposit from which they had come was equivalent in time to " the middle part of the Gloucestershire Cephalopod-Bed and with the lower 100 feet of the Yeovil Sands near Yeovil."[2] Additional specimens of ammonites would lead him to regard the *whole* of the Grey Beds as *dispansi* in date (*vide* Appendix II., p. 209).

In May, 1910, Part III. of the Jubilee Volume (" Geology in the Field ") of the Geologists' Association appeared, in which there is an excellent article by Mr. Robert S. Herries, entitled " East Yorkshire " (*loc. cit.*, pp. 594-595). The closeness in the dates of publication of Mr. Buckman's and Mr. Herries' papers did not permit of a reference to the former in the latter, and Mr. Herries contents himself with the remark that :—

> " These marine beds [in the Yorkshire estuarine series] all correspond to different horizons of the Inferior Oolite of the south of England, so that when the Cornbrash is found succeeding the Estuarine beds apparently without a break, it is clear that the Bathonian if represented at all, must correspond with the Upper Estuarines or a part of it."

(i.) *On the lower and upper limits of the Lower Oolites in Yorkshire.*—Generally, the dividing-line between the Lias and Oolites in Yorkshire is very obvious, because, whilst the former consists mainly of clay, the latter comprises sandstones, shales and impure limestones. But whilst this is the rule, here and there other beds come in *between the Upper Lias clays and the undoubted Estuarine sandstones and shales*, which—on account of their transitional nature both as regards lithic structure and (to a less extent) contained fossils—render it very difficult at first sight to say precisely where the Lias ends and the Lower Oolites begin. This is more particularly the case if the palæontological, and especially the ammonite evidence is ignored.

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[1] Proc. Geol. Assoc., Vol. XIX., Pt. 10 (1906), pp. 420-423.
[2] Quart. Journ. Geol. Soc., Vol. LXVI. (1910), pp. 81-82.

It so happens that at the locality in Yorkshire where the junction of the Lias and Oolites is most conveniently studied, namely, at Blea Wyke, there is also the best development of these intervening "Transition Beds" or "Blea-Wyke Beds" as they have come to be called. The following record will give an idea of their nature and date :—

Table II.—SECTION OF THE BLEA-WYKE BEDS, ETC., AT BLEA WYKE, RAVENSCAR.

			Thickness in Feet.	Ins.
Aalenian (*murchisonæ* to *? scissi*).	I.	Sandstone, ferruginous, with scattered pebbles	10	0
	II.	*Nerinæa*-Bed : numerous gastropods and lamellibranchs : 1 foot to	1	6
		(*No evidence of deposits of opaliniformis, aalensis and moorei hemeræ*)		
BLEA-WYKE BEDS. Yellow Beds. *dumortieriæ.*	III.	Sandstone, greenish-yellow with bands of pebbles	25	0
	IV.	Brown shaly bed	1	0
	V.	Sandstone, brown, full of specimens of *Terebratula trilineata* auctt. ; *Trigonia ramsayi* Wr., *Gresslya abducta* (Phil.)	2	0
	VI.	(*a*) Sandstone, yellow, with a band of belemnites and pebbles at the base	1	0
		(*b*) Sandstone, yellow, ferruginous ..	2	0
		(*c*) Sandstone, soft, yellow, shaly, very conspicuous	1	0
		(*d*) Sandstone, soft, yellow, ferruginous, with irony knobs and concretions : in the lower part are numerous specimens of *Pteria* with *Serpula*, *Rhynchonella cynocephala* auctt, etc.	20	0
		(*e*) Soft rotten band with blue shaly clay and large lump-like masses of sandstone	1	0
		From Bed VI. have been obtained specimens of *Dumortieria externicostata* Branco, *D.* aff. *multicostata* S. Buckman, *Polyplectus* cf. *pietralatae* (Parish and Viale) and *Pseudolioceras* cf. *quadratum* S. Buckman.		

				Thickness in Feet.	Ins.
BLEA-WYKE BEDS.	Grey Beds (= Midford Sands of some Authors). *dispansi.*	*Serpula* Beds.	VII. (*a*) Sandstone grey with a much runnelled surface ; *Rhynchonella cynocephala* auctt., *Terebratula* sp., *Aulacothyris blakei* (Walker), *Lingula beani* Phil., *Dentalium elongatum*, *Pteria inæquivalvis* auctt., *Pecten* sp., fucoids 2 spp., Lignite . .	4	0
			(*b*) Brown ferruginous band with a layer of belemnites at its base. Often not much more than a parting . .	1	0
			(*c*) Sandstone, grey, false-bedded, very micaceous with a band rich in *Serpulæ* at the base	5	6
		Lingula-Beds.	VIII. Sandstone, grey, shaly. At 4 feet from the top is a line of nodule-like burrs containing *Phlyseogrammoceras dispansum* (Lyc.), *Hudlestonia affinis* (Seebach), *H.* aff. *affinis* (Seebach), *Lingula beani* Phil., *Pinna cuneata*, Phil., *Cerithium quadrilineatum*, etc.	25	0
			IX. Shale soft grey with *Lingula* at the base	7	0
			From the "Grey Beds" have been obtained *Pseudolioceras* sp. nov., *Hudlestonia wykiensis* S. Buckman, *H.* cf. *wykiensis* S. Buckm., *H.* cf. *sinuosa* S. Buckm. non Bayle, *Glyphæa birdi* Bean MS., *Orbiculoidea reflexa* (Sow.), etc.		
Striatulus-Shales (top part may be of *dispansi* ; and *struckmanni* hemeræ :* main portion of *striatuli*).			Shaly rock full of spangles of white mica : 50 to 70 feet	60	0
Alum Shales.			Shales with a band of limestone-nodules full of specimens of *Pseudomonotis substriatus* at the top.		

* There is no evidence for any deposit of *pedici* hemera.

Previous to the present time the only portion of the Yellow and Grey Beds that has been definitely dated has been the *Lingula*-Bed portion of the Grey Beds. This Mr. Buckman has dated as *dumortieriæ-dispansi*. Now, however, it is known that the Yellow Beds are of *dumortieriæ* hemera and the Grey Beds of *dispansi* ; while the *Nerinæa*-Bed is mainly *murchisonæ*. Even if there is some deposit of *scissi* hemera closely associated with that of *murchisonæ* date in the *Nerinæa*-Bed, there is a considerable non-sequence between the *Nerinæa*-Bed and subjacent sandstone, for no evidence of any deposits of *opaliniformis*, *aalensis* or *moorei* hemeræ has yet been obtained.

The division-line between the Lias and Oolites is now generally drawn between the *aalensis*- and *moorei*-Beds, and as both are absent from Blea Wyke it follows that a marked non-sequence coincides with the line of separation—a state of affairs that was scarcely expected.

In the generalized statement of the sequence of the component subdivisions of the Blea-Wyke Beds (Table II.) I have inserted all the information that is likely to be necessary in view of the fact that detailed remarks on their correlation follow in the Appendix contributed by Mr. Buckman, and the significance of the non-sequence between the Lias and Oolites at Blea Wyke may now be considered.

There is abundant evidence to show that in Yorkshire Liassic times were brought to a close by oscillatory movements of the sea-floor. The data at present available point to a general uplift in the north-west, incipient faulting in the neighbourhood of the present headland called "The Peak," and local furrowing by water of certain portions of the upraised Lias-floor. More detailed work may make it possible to show that certain anticlinal and synclinal flexuring of the Liassic rocks took place before the deposition of the Oolites and was attended by the additional interesting expression of crust-movement—faulting. At all events, whatever precisely took place in closing Liassic times the earth-movements were not insignificant. They apparently were sufficient to uplift and to cause the erosion of the Lias in the north-western portion of East Yorkshire[1] down as far as the Lower Lias ; to cause the channelling of the Upper Lias down to within a few feet of the Jet Rock at the extreme southern end of Cold Moor in Raisdale ; and while these movements encouraged deposition on the depressed side of the Peak fault, they effected a very sporadic accumulation of sediment in certain other parts. Also, besides causing the inclusion of derived fossils in later beds, they interfered with the clear sequential entombment of the successive faunas and so have made careful collecting and the accurate discrimination of species doubly imperative if the true history of the Yorkshire Lower Oolites is to be pieced together. Such detailed work, however, is the province of local observers ; it must suffice here to state that the *Nerinæa-cingenda*-Bed and its associated deposits, which constitute the Dogger proper, or their equivalents, rest, where they are present, as a rule non-sequentially, upon a deeply-eroded surface of the Lias and that therefore *the division-line between Lias and Oolites is usually sharply defined.*

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[1] At Saltwick Bay derived ammonites "unmistakably Lower-Lias forms" occur between the Dogger and the Upper Lias. Mem. Geol. Surv., "Jurassic Rocks of Britain," Vol. I. (1892), "Yorkshire." p. 159.

The topmost sub-division of the Lower Oolites is the Cornbrash.

In Yorkshire the Cornbrash has not been detected to the south of a line drawn in a westerly direction a little north of west from Filey ; but to the north thereof it has generally been found in its proper stratigraphical position wherever natural or artificial sections have been available.

In this county it does not closely resemble lithically the deposit that bears the same name in the South-west of England. Instead of being mainly a brown rubbly limestone, it is principally shales with a median band of limestone, which is of a bluish colour on the coast, but everywhere very fossiliferous. The shaly beds above the fossiliferous limestone have been called the "Clays of the Cornbrash," and authorities have been divided as to whether they should be classed with the Cornbrash or with the overlying Oxfordian. I would regard them as best grouped with the Cornbrash.

It has also been questioned whether the Yorkshire Cornbrash is contemporaneous with the Cornbrash of other parts. *Clydoniceras discus* (Sow.) does not appear to have been recorded from Yorkshire ; but specimens belonging to the genus *Macrocephalites* are not infrequent. More satisfactory correlations may, however, be accomplished with the aid of the brachiopods. Thus Mr. Buckman writes to me :—

> Taking the Cornbrash as consisting of the three zones :—
>
> (1) *Macrocephalus,*
> (2) *Lagenalis,* and
> (3) *Intermedia*
>
> the Yorkshire Cornbrash perhaps shows 1 and 2 mostly ; but the Dorset Cornbrash is more often 3. Zone 2 is found at places in Somerset ; zones 2 and 3 were found on the Badminton Railway ; and zone 2 is very fossiliferous at Fairford and again at Northampton. The Stilton rock is, I gather, mostly zone 3. The top zone (1) is finely developed at Garsden near Malmesbury, Wiltshire ; but I do not know it in Dorset or Somerset. I know that its ammonites are fairly common in Yorkshire.

It will be unnecessary to go into details with regard to the geographical distribution of the Cornbrash in Yorkshire or with regard to sections of it ; but it may be as well to state that it is thinnest where it first appears from beneath the Oxfordian on the coast, and thickest away to the west in Newton Dale (see Table I.).

At the time Mr. Paris and I visited the coast between Filey and Scarborough, there were some large blocks of dark-coloured Cornbrash limestone on the sands of Gristhorpe Bay, which had fallen from the precipitous cliffs above. They were full of fossils in an excellent state of preservation and are denoted in the generalized section on page 213 by an asterisk. The others we collected from the well-known little reef under the frowning heights of Red Cliff, Cayton Bay, which is said to have yielded most of the specimens that are now distributed in our many museums and labelled as having come from the Yorkshire Cornbrash.

A small outlying patch of Cornbrash occurs at the Falsgrave Brickworks on the Scarborough and Seamer Road and tumbled masses may be examined on the steep slopes of the workings. Here the limestone is very " rotten " and of a deep brown colour ; while only casts of the fossils are available. These, however, are very " sharp." Amongst the specimens obtained here was a piece of an ammonite, which Mr. Buckman calls *Macrocephalites subtumidus* (Waagen).

II. SUB-DIVISIONS RECOGNIZABLE IN THE LOWER OOLITES OF YORKSHIRE.

In Gloucestershire, between the Cornbrash and the Upper Lias, is a great mass of rock predominantly marine. In Yorkshire the corresponding deposit is as essentially estuarine : great masses of sandstone occur interbedded in the sandy shales, which are often rich in plant-remains ; while only narrow bands of relatively inconspicuous impure limestone represent the deposits that were formed under temporary marine conditions and in many places have ill-defined upper and lower limits. But it is to these comparatively insignificant bands that one must turn if reliable data for correlation purposes are to be obtained.

Counting the Cornbrash, there are five marine beds known in the Yorkshire Lower Oolites. In descending order they are :

(1) Cornbrash,
(2) Scarborough Limestone,
(3) Millepore Limestone,
(4) Eller-Beck Bed, and
(5) The Dogger, of which the most important layer is the *Nerinæa*-Bed.

(1) CORNBRASH—Concerning this sub-division sufficient has already been said.

(2) THE UPPER ESTUARINES.—The Upper Estuarines come between the Cornbrash and the Scarborough Beds, and in the district to the north of a line drawn westwards from Gristhorpe Bay comprise two divisions, namely :—

- Upper Estuarines
  - (*a*) An upper, which comprises ..
    - (1) Thin beds of sandstone or quartzite and shale resting on
    - (2) Extremely irregularly-bedded sandstones, which are often replaced by shale, with an occasional ironstone seam ; and
  - (*b*) A lower division, which is usually a well-defined massive bed of sandstone called the " Moor Grit."

Concerning the upper division there is little to say. Its beds are of much the same appearance over the whole of the Oolitic tract to the north of the line mentioned above, only in the district to the north of the Esk the deposits are hardened clays rather than shales, while in the neighbourhood of Danby Beacon, near the top, are some bands that are very similar to the " White Flint " to be noticed shortly.

As regards the MOOR-GRIT, it is not so readily-separated from the overlying sandstones where it first appears on the coast ; but it rapidly developes in prominence and importance to the north, and in the neighbourhood of Cloughton Wyke yields a very excellent building-stone and, at Smeaton, large flags.

In the neighbourhood of Whitby and westwards over the district north of the Esk, the Moor-Grit is sometimes mainly represented by a hard wedge-bedded quartzite, which is locally called " White Flint," and has been extensively worked for road-metal, and at others, by a sandstone excellent for building-purposes.

On the Eston outlier, near Guisbrough, the Moor-Grit is thin and the feature that it makes is dwarfed by that produced by the outcrop of the underlying Crinoid-Grit of the Scarborough Beds ; but in the western portion of the main upland mass that lies to the south of a line drawn east and west along the Esk, both upper and lower divisions are normally developed. The Moor-Grit there, however, admits of the following sub-division :

(1) into an upper part, which varies considerably and contains beds of quartzite, whose detached fragments weather white and dot the moorland ; and
(2) a lower part, which remains a solid white free-stone, well-bedded, easily worked, very durable and hardening on exposure, but in a few cases, as on Bilsdale West Moor, Hawnby Moor, etc., is partly of gannister nature.

South of the line referred to above as drawn westwards from Gristhorpe, the Upper Estuarines are found in the Howardian Hills, where they are about 50 feet thick, and have an occasionally-indurated bed of sand at their base to lithically represent the Moor-Grit. In the neighbourhood of the Derwent, the beds are much the same ; while in South-east Yorkshire they comprise sands and clays from 20 to 30 feet thick.

As regards fossils, the Upper Estuarines are unfortunately singularly barren and but for a plant-bed in the lower portion, such as is seen at Scalby Ness, between Scarborough and Cloughton, would have proved barren in the extreme. The only molluscan remains recorded hitherto have been some ill-defined casts of a species of *Anodon* or may be of a *Pleuromya* at the very base.

The Upper Estuarines, as already noted, occur between the Cornbrash and Scarborough Limestone. The newest portion of the latter that has been definitely dated is of *blagdeni* hemera. Hence it follows that the Upper Estuarines occupy the same stratigraphical position as the Top-Beds of the Inferior Oolite and the deposits of the Great-Oolite Series (be they mainly clay or mainly limestone) of the South-west of England. I have not visited the Lincolnshire sections of the Lower Oolites yet and so have to rely upon the observations of others, but Mr. Ussher thinks that the evidence favours the view that in North Lincolnshire the Great-Oolite Limestone *has attenuated and died out*, and that the Upper Estuarines of that part have come into contact with the Blisworth or Great-Oolite Clay, and that it is the equivalents of these two deposits combined that make up the Upper Estuarines of the Yorkshire coast and moors.

Scarborough Beds.—This term is suggested instead of that of "Scarborough Limestone," because limestone really plays a very subordinate part in their composition.

Over the greater part of the tract where the Lower Oolitic rocks occur in Yorkshire, the Scarborough Beds are divisible into three main portions :—

(*a*) an upper portion in which shales predominate ;
(*b*) a middle portion in which sandstone or grit is the main constituent ; and
(*c*) a lower portion in which such limestones as do occur in the Scarborough Beds are most in evidence.

South of Scarborough these three divisions are not well-marked, and where the Beds first appear on the coast at Gristhorpe Bay from beneath the younger rocks they do not measure more than from 3 to 7 feet. At White Nab (Plate XXII.), however, they have increased to 30 feet in thickness and at one horizon in particular are replete with specimens of a *Gervillia*, which has generally been called "*Gervillia acuta*, Phillips," but which Mr. Paris thinks is distinct, and to which he has given the name of *Gervillia scarburgensis*. Here also a number of ammonites have been found, such as *Teloceras coronatum* (Qu. non Brug.), *Stepheoceras subcoronatum* (Oppel), and *Parkinsonia* sp. (fragment).

There is a certain amount of iron in the Scarborough Beds that are exposed in the sections south of the seaside resort whence they derive their name, and as it oxidizes and imparts a red streaky appearance to the rocks, it is useful when seen in the matrices of fossils labelled simply "Yorkshire Coast" as suggesting for them a south-Scarborough derivation.

At Hundale Point, Cloughton Wyke, the Scarborough Beds are readily accessible, very fossiliferous and well-developed, and attain a thickness of 71 feet 2 inches. This increase is mainly due to the presence of a considerable thickness of shale, which is said to have "come in in the upper part."

This section has been described at length by several authors and for the present purpose it will suffice to refer the reader to Fox-Strangways' record[1] and to point out (1) that the four-foot bed referred to in that record as containing *Pentacrinus* (*Isocrinus*) is probably on the horizon of the Crinoid-Grit of sections further west (on the Eston outlier, for example) ; (2) that *Belemnites*

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[1] "The Jurassic Rocks of Britain," Vol. I. (1892), "Yorkshire," p. 232.

ellipticus Miller (= *B. giganteus* M. & L.), while recorded at *this* locality from above *and* below the probable Crinoid-Grit equivalent is generally most prevalent *above* ; while (3) specimens of "*Gervillia acuta* Phil.," occur the most abundantly in the limestone-division (*c*) *below* the probable Crinoid-Grit equivalent. Indeed, in studying the recorded sections of the Scarborough Beds it is noticeable that the maxima of *Belemnites ellipticus* Miller,[1] of isocrinoid-ossicles and of *Gervillia*, occur in this sequence in descending order and function as approximate indices to the three divisions (as regards lithology) of the Scarborough Beds. *Belemnites ellipticus* Miller, and *B. quinquesulcatus* Blainv., are not at all uncommon in the beds of *sauzei* date on the Cleeve Hill plateau in the Cotteswold Hills, near Cheltenham.

At Ravenscar (Blea Wyke) the Scarborough Beds are much the same as regards faunal and lithic characters as their equivalents at Hundale Point, only they are thicker—89 feet instead of 71 feet 2 inches.

When the Scarborough Beds are traced across Howdale Moor it is noticed that thin flaggy sandstones occur very persistently in the *upper portion* of the shale-division (*a*) and are characterized more particularly by a little *Gryphæa* (see Phillips, "Geol. York. Coast," 3rd ed., Pl. IX., f. 26). In the neighbourhood of Lambfold Hill, the probable equivalent to these flaggy beds is much more gritty and prominently developed.

Generally speaking, in the neighbourhood of Scarborough, the three divisions of the Scarborough Beds are not very well-defined ; but in the neighbourhood of Whitby they become much more definite, as the sections recorded by Fox-Strangways at Gate Holm Beck, Spittle Beck and Shawm-Rigg Beck, etc., show.[2]

In the district north of the Esk, as for example in the neighbourhood of Scaling, the three divisions are very well marked. The lowest or limestone-division includes many calcareous bands, sometimes approaching nearest to sandstones and at others to true limestones. The middle division, or that in which the arenaceous constituent usually predominates, becomes to the west a coarse grit, which on the Eston outlier is composed of quartz-grains often as large as peas, and is replete with the dis-

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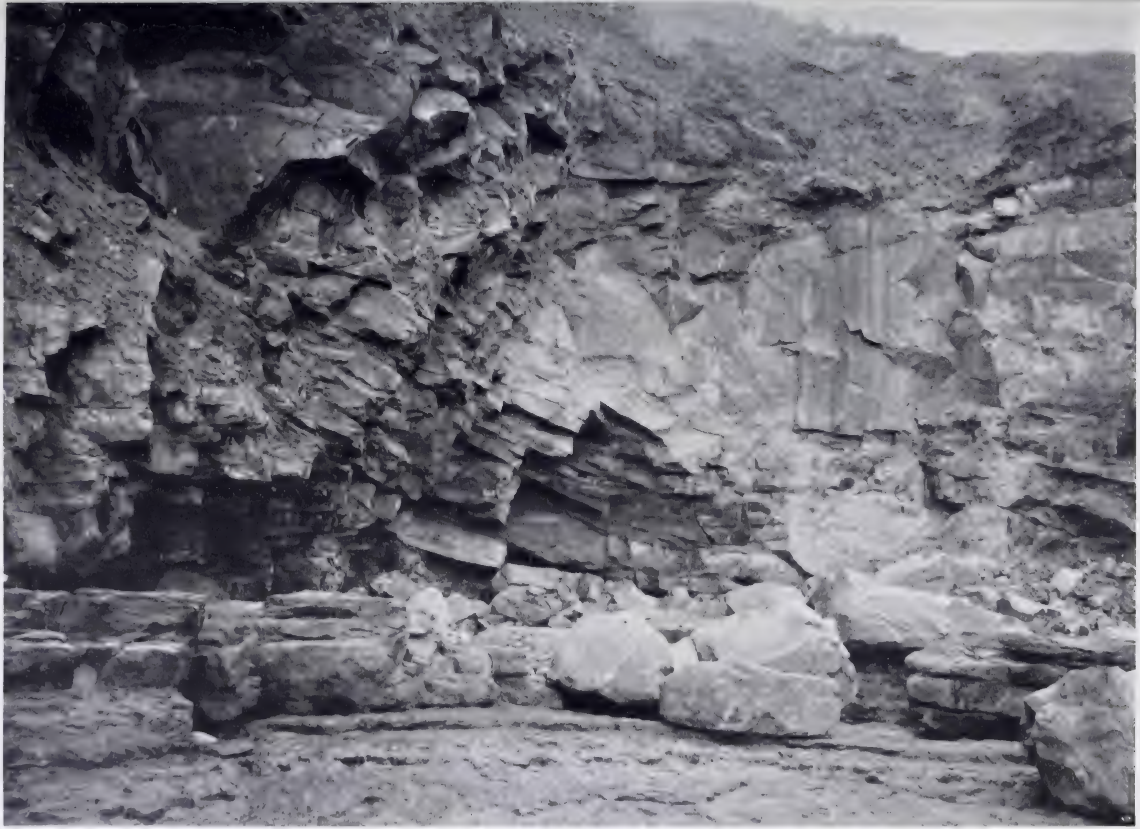
[1] *Pseudomonotis braamburiensis* (Phil.) appears to have its maximum in the shale-division.
[2] "The Jurassic Rocks of Britain," Vol. I., "Yorkshire," pp. 237-238.



Photographed by Godfrey Bingley, Headingley, Leeds.

Portion of the cliff on the North side of White Nab, near Scarborough, showing the Gervillia Bed of Scarborough Series at the base.

membered ossicles of isocrinoids. Where this Crinoid-Grit is thick on the Eston outlier, the underlying limestone of division *c* is thin—so thin as to have led the late C. Fox-Strangways to remark, "it is very doubtful if any limestone exists below this grit."

Coming now to the western half of the main upland mass that is situated to the south of a line drawn east and west along the valley of the Esk, the limestone-division is continuous westwards, but attenuates where the Crinoid-Grit thickens. In places the reduced thickness of the limestone is probably due to dissolution by carbonated waters that have percolated through the porous overlying Crinoid-Grit. In the neighbourhood of Snaper House (on Collis Ridge on Helmsley Moor) the blue limestones of division *c* have been extensively worked for road-metal and must be at least 10 feet thick.

The Crinoid-Grit, often replete, as on Osmotherley Moor, with isocrinoid remains, is well-developed in this western tract,[1] increasing in thickness towards the north in the direction of the Eston outlier at the expense—as already noted—of the underlying limestone.

In this western tract several changes take place in the composition of the shaly division of the Scarborough Beds. At Spindle Thorn, on Spaunton Moor, a noticeable 5-foot bed of very hard blue limestone makes its appearance in the *lower* part, and may conveniently be called the "Spindle-Thorn Limestone." In the *upper* part of this same shale-division a thick fossiliferous grit becomes prominent and forms great spreads, often more than a square mile in extent on the ridges and watersheds that separate the various dales. As it is most conveniently studied in the neighbourhood of Lambfold Hill, the term "Lambfold-Hill Grit" may not be inappropriate wherewith to designate it.

In Bogmire Gill, at the south-eastern termination of Collis Ridge, the following succession may be discerned :—

Scarborough Beds.	(*a*)	Shales	20 feet +
		Spindle-Thorn Limestone	a few feet
	(*b*)	Crinoid-Grit	10 feet
	(*c*)	Limestone, blue.	

and on the west side of Bilsdale, the next dale to the west, the total thickness of the Scarborough Beds cannot be far short of 70 feet.

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[1] It is at least 40 feet thick on the watershed between Scugdale and Raisdale in the tract west of Bilsdale.

With local variations the three divisions of the Scarborough Beds can be traced along the Hambleton Hills to the greatly-faulted tract in the neighbourhood of Coxwold.

When sections become available again to the south-east, the beds are seen to have undergone a change. Instead of the three clearly-marked divisions of shale, sandstone or grit, and limestone, there are only two. The lower (*c*) comprises beds of hard blue fossiliferous limestone, which at Brandsby have long been worked for road-metal under the name of " Brandsby Roadstone," and sometimes are sufficiently fissile to afford slabs thin enough for roofing purposes.

The upper division (*a* and *b*) comprises at Thirkleby Barf, near Coxwold, " soft massive sandstones with casts of fossils [? division *b*], which become more flaggy in the upper part [? division *a*] "[1] but in the Howardian Hills this upper division is " a brown porous grit, very full of casts of *Avicula braambuiriensis*" and with the lower totals some 40 feet in thickness.

In Cram Beck and in Stonecliffe Wood, that is, in the neighbourhood of the Derwent Valley where it traverses the escarpment of the Lower Oolites, the two divisions are very similarly developed to what they are in the Howardian Hills, only in the upper sandy division in the immediate neighbourhood of Cram Beck are often found great burrs or doggers crowded with fossils, and in Stonecliffe Wood, several bands of fossiliferous limestone full of specimens of *Pseudomonotis*, *Gervillia*, *Pleuromya*, *Astarte*, etc.

" About Burythorpe where these beds should come out again," writes Fox-Strangways, " there is not a trace of any fossiliferous rock at this horizon " (p. 249). Thus here, as is the case also where they first appear on the coast at Gristhorpe, the Scarborough Beds are very thin.

The date of the Scarborough Beds may now be considered.

As pointed out by Mr. S. S. Buckman in Appendix I., there is ample evidence for deciding that a portion is of *blagdeni* hemera. Another portion may be of *sauzei* date ; but it is obvious that a great deal more careful collecting from the beds *in situ* will have to be accomplished before anything more definite can be said.

As far as the facts that have been obtained will permit I have endeavoured to indicate the changes that take place in the lithology of the component divisions of the Scarborough Beds as they are followed round their outcrop—from the coast-sections at Gristhorpe to the inland quarries and scarps in the neighbourhood of the Derwent Valley. No evidence of any later deposit taking part in the formation of the Scarborough Beds than that of *blagdeni* hemera has yet been obtained.

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[1] See note on p. 197.

MIDDLE ESTUARINES.—The stratigraphical position of these deposits is between the Scarborough and Millepore Beds. Like the Upper and Lower Estuarines they comprise beds of sandstone, sandy shales and thin coal-seams ; but their upper and lower limits are not always too well defined, there being a gradual passage into the sub- and super-jacent marine deposits both as regards faunal characters and lithic structure.

At Gristhorpe Bay the Middle Estuarines are 40 to 50 feet thick ; at Cloughton and Blea Wykes about twice as much ; in the Howardian Hills, where they are more arenaceous (" Middle Sands of Cram Beck "—Hudleston), from 20 to 60 feet ; while in South-east Yorkshire, where clay participates with the sand in their composition, they total 20 feet or more.

The Scarborough Beds are well developed to the north of a line joining Gristhorpe and Kirkham Abbey, and therefore over that tract the approximate upper limit of the Middle Estuarines is fairly easy to determine. But in South-east Yorkshire, where the Scarborough Beds are not thus prominent the fixing of the upper limit is a matter of some difficulty.

On the other hand, the lower limit is easiest fixed in the district to the *south* of a line drawn westwards from Gristhorpe to Kirby Knowle on the western escarpment, for over that tract the Millepore Bed (or Whitwell or Cave Oolite) is prominently developed, while it is absent—as an easily recognised bed—from over the extensive moorland that is drained by the River Esk and its numerous tributaries.

Over the district referred to a coal-seam affords the readiest means of approximately locating the lower limit of the series.

The Middle Estuarines are principally noteworthy for the occurrence in them of a very rich plant-bed, which rests immediately on top of the bottom mass of sandstone at Gristhorpe Bay. This bed has yielded innumerable plant-remains, specimens of which have found their way into the collections of most geologists who have worked the Oolites of the Yorkshire Coast.

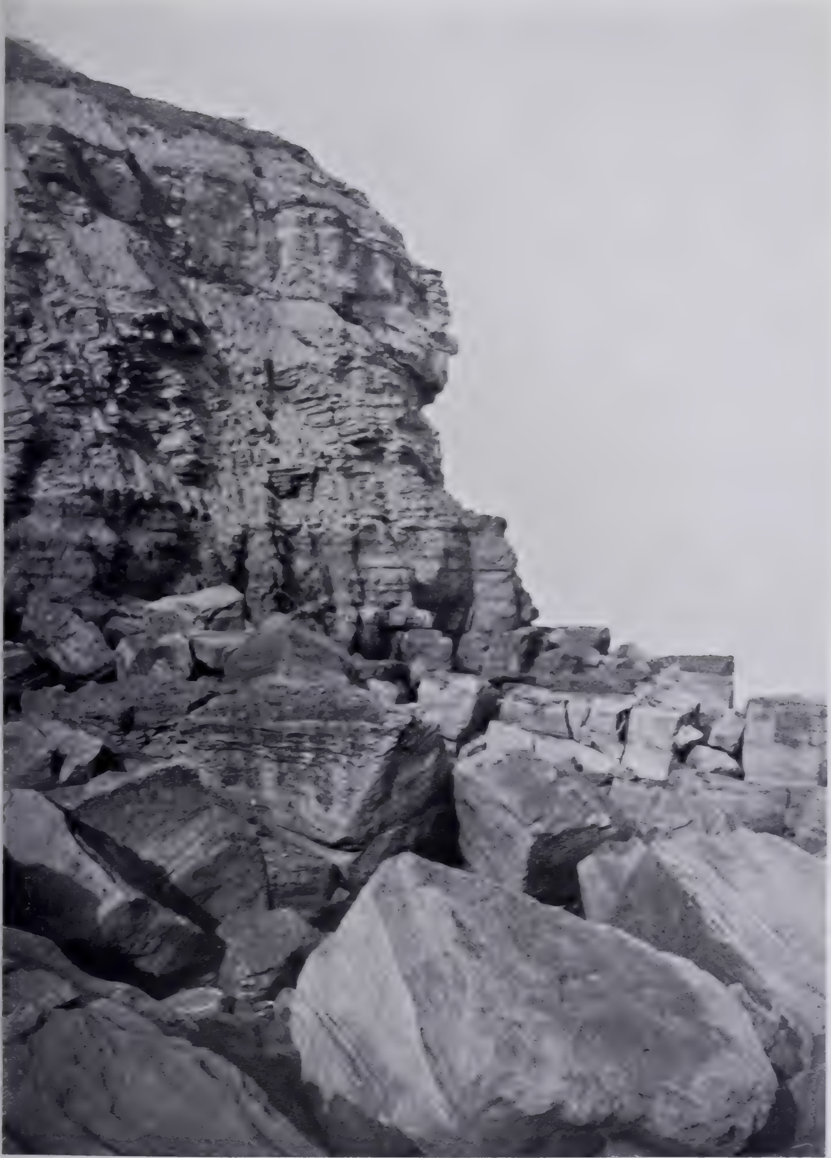
The date of the Middle Estuarines is approximately fixed by the dates of the sub- and super-jacent marine beds. The Scarborough Limestone being principally of *blagdeni* but possibly in part of *sauzei* date and the Millepore Bed of *discitæ* it follows that the intervening deposits, that is, the Middle Estuarines, must be provisionally regarded as of *witchelliæ-shirbuirniæ* (before, *witchelliæ-sonniniæ*) hemerae.

Millepore Bed.—The Millepore Bed is a well-known marine band in the Yorkshire Lower Oolites, but like the other marine bands is subject to considerable variations and ofttimes has ill-defined upper and lower limits—especially upper.

Thus at Cayton Bay, above the true Millepore-Bed is something like 25 feet of sandstone and sandy shales which contain marine fossils in them, and presumably must be associated with the Millepore Bed. Hence, the term "Cayton Bay Beds" might be used for the conjoint deposit : to include (*a*) the overlying sandstones and shales with marine fossils, and (*b*) the Millepore Bed proper. In the Howardian Hills the top part of this upper portion (*a*) is sufficiently developed to have attracted special notice and was called the "Upper Limestone" by Hudleston.

On the coast the Millepore Bed proper is seen best at Osgodby Nab at the north-eastern end of Cayton Bay, and at Cloughton Wyke. At Osgodby Nab the Millepore Bed, which is said to be about 20 feet thick here, has been broken up by the waves into huge blocks, the weathered surfaces of which exhibit innumerable fragments of the characteristic polyzoan *Entalophora* (*Spiropora* or *Cricopora*) *straminea* (Phil.) and of crinoids, etc. (Plate XXIII.). At Cloughton Wyke the Millepore Bed forms a conspicuous reef and presents much the same features as at Osgodby Nab, only it is thinner.

North of Cloughton Wyke the Millepore Bed becomes more and more attenuated and arenaceous until it is lost sight of altogether after a place "by the side of the high road from Staintondale to Bay Town [Robin Hood's Bay]." It has not been seen again until the whole of the moorland tract has been traversed, and the neighbourhood of Kirkby Knowle arrived at. Thence southwards it is exposed here and there on the western escarp-



Photographed by Godfrey Bingley, Headingley, Leeds.

Osgodby Nab, Cayton Bay, near Scarborough.
[The large blocks are of Millepore-Limestone.]

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ment, occasionally containing crinoid-remains; while in the Howardian Hills it is represented by a deposit that admits of dual division. The lower portion is subject to some variation, but is generally a well-bedded freestone and is known as the "Whitwell Oolite." The upper portion as a rule consists of sands and siliceous limestones (which often weather into roundish balls or doggers, or large tabular slabs); but in Cram Beck the lower part of this upper division is more argillaceous and from time to time has been worked for Fullers' Earth.

Fox-Strangways has given a lengthy list of fossils "from the Whitwell Oolite, or from the sandy beds associated with the same," but unfortunately he does not say which are from the Oolite and which are from the sandy beds. Mr. Paris and I collected some very fair specimens of *Spiropora straminea* (Phillips) from the Whitwell Oolite of the Mount-Pleasant quarries, near Whitwell, and also numerous well-preserved examples of the curious gastropod-like serpula *Vermicularia nodus* Phil. Other fossils included portions of the tests of *Pygaster semisulcatus* Phil., *Galeolaria socialis* (Goldf.). *Acanthothyris* sp., etc.

On the eastern side of the Derwent Valley, around Westow, the Whitwell Oolite has been extensively quarried, and its outcrop is fairly regular from Leavening southwards until it is obscured by the overstep of the Cretacic rocks.

In South-east Yorkshire the Whitwell Oolite is called the "Cave Oolite." It has been extensively worked around Newbald and South Cave and crops out in the bed of the Humber giving rise to "Brough Scalp."

With regard to the correlation of the Millepore Bed with its probable equivalent in Gloucestershire, its development on the coast at Cloughton at once reminds one of the *Buckmani*- and Lower *Trigonia*-Grits and also of the Pea-Grit. *Spiropora* occurs not uncommonly in the Pea-Grit of the Cotteswolds; abundantly in the Lower *Trigonia*- and *Buckmani*-Grits (especially in the latter); and, as the name implies, is the characteristic "millepore" of the Millepore Bed or of its equivalents inland—the Whitwell and Cave Oolites.

The Cave Oolite is equivalent in part at least to the Lincolnshire Limestone, certain of the component deposits of which are of *discitæ* hemera (*vide* Appendix I., footnote, p. 205). As the Lower *Trigonia*- and *Buckmani*-Grits are also of this hemera, the Millepore-Bed, Whitwell and Cave Oolites (in part at least) and Lower *Trigonia*- and *Buckmani*-Grits of the Cotteswolds come into line.

The echinoid evidence would seem to link the Millepore Bed and its equivalent limestones with the Pea-Grit ; but against this must be placed the evidence of the spinose rhynchonellids of the genus *Acanthothyris*. In the *Buckmani*-Grit of the Cotteswold Hills little acanthothyrids are not at all uncommon, and some specimens have been compared with the *Acanthothyris crossi* of the late J. F. Walker from the Lincolnshire Limestone. Such forms and another one with a very regular arrangement of its spines (like one well-known to workers in the Cotteswold Hills) have been noticed, but only rarely in the Millepore Bed. Phillips has figured a specimen apparently of this latter type which he obtained from the Millepore Oolite of near Cave ("Geology of Yorkshire," Part I., Plate IX., Fig. 18, p. 243).

The deposits of *discitæ* date in Yorkshire and the Cotteswolds contain a number of species that are common to the two districts, such as *Serpula socialis* (Goldfuss), *S. deplexa* Bean, *Spiropora straminea* (Phil.), *Acanthothyris* sp. nov., *Gervillia prælonga* Lycett, *G. whidbornei* Paris, *Lima bellula* M. and L., *L. duplicata* Sow., *Ctenostreon pectiniforme* (Schloth.), *Camptonectes lens* (Sow.), *C.* cf. *aratus* (Waagen), *Pinna cuneata* Phil., *Protocardia buckmani* (M. and L.), *Ceromya bajociana* d'Orb., *Cucullæa elongata* Sow., *Cypricardia* spp., *Isocardia cordata* J. Buckm., *Volsella ungulata* (Y. and B.), *Trapezium* sp., *Trigonia* spp., *Natica* sp., etc.

The Lower Estuarines.—These beds vary in thickness from 286 feet on the coast at Blea Wyke, to 120 feet in the Howardian Hills, 50 feet at Acklam and to only 15 feet in South-east Yorkshire. They are more arenaceous than those composing the Middle and Upper Estuarines, having in their lower portion massive sandstones ofttimes curiously false-bedded and extremely irregular, and contain (at Blea Wyke at about two-fifths of the distance down below the Millepore-Bed) an important marine band called the "Eller-Beck Bed."

The Eller-Beck Bed consists of sandstone in the upper portion and shale with associated beds of ironstone in the lower. In the Howardian Hills this sandy upper portion passes into a Hydraulic

Limestone, which is continuous into South-east Yorkshire, where—on account of the attenuation of the portion of the Lower Estuarines which comes above—it occurs close under the Cave Oolite.

Before the deposition of the Lower Estuarines, the Dogger appears to have undergone some channelling, for in places the bottom sandstones of the Lower Estuarines occur in hollows excavated through the Dogger and into the Upper Lias.

The Lower Estuarines have yielded no fossils whereby to date them, and therefore their approximate age must be assumed to be of the hemeræ intermediate between *discitæ* and *murchisonæ*—that is of *bradfordensis* and *concavi* hemeræ.

THE DOGGER.—This is perhaps the best known of the marine bands in the Lower Oolitic Rocks of Yorkshire, and in places contains fossils abundantly. It varies considerably from place to place both as regards thickness and lithic structure. (Plate XXIV.)

> "It changes," writes Fox-Strangways, "from a sandstone to a limestone or a valuable ironstone, and from a fine-grained shaly bed to a nodular calcareous oolitic rock with little bedding. In some places it seems to form a passage bed between the Lias and the Lower Oolite, in others it rests on a distinctly eroded surface of the shales, while here and there it is itself cut out entirely by the Estuarine Sandstones, which rest immediately on the Alum Shale." (p. 154).

At Blea Wyke a bed full of examples of *Nerinæa* and other gasteropods and lamellibranchs is its most interesting member. Below it is a deposit of sandstone, 25 feet thick, lined with blackish nodules, which Hudleston and Herries would assign to the Dogger, but which I should feel inclined to class with the underlying Blea-Wyke Beds.

Above the *Nerinæa*-Bed at Blea Wyke is more sandstone—10 feet of it; but this succession of sandstone, *Nerinæa*-Bed, sandstone, only obtains on the downthrow side of the Peak fault. Scarce half-a-mile away at the Loftus Alum Works, the Dogger is quite different, relatively thin, and contains numerous derived fossils, many of which are Liassic ammonites.[1]

The blackish pebbles in the sandstone *above* the *Nerinæa*-Bed at Blea Wyke, some of which have been identified as rolled Liassic fossils, together with those derived specimens in the Dogger of the Loftus workings point to some areas having been exposed and partially eroded, while the sandstones with the black pebbles in them were being deposited.

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[1] Bed 5 in Mr. Herries' record (Proc. Geol. Assoc. Vol. XIX., 1906, p. 425) yielded him a specimen that was identified by Mr. S. S. Buckman as *Sequenziceras* cf. *algovianum* (Oppel), ? sp. nov. (derived); bed, *Grammoceras* aff. *striatulum* (J. de C. Sow.), *striatuli* hemera (derived); while specimens of *Phlyseogram.* cf. *dispansum* (Lyc.), *dispansi* hemera, and *P. metallarium* (Dum.), also *dispansi* hemera, were obtained.

In the neighbourhood of the present "Peak" these crust-pressures found relief in faulting and while on the Scarborough side of the fault the Blea-Wyke Beds, *Nerinœa*-Bed, and overlying sandstone were preserved, on the other side the more irregularly developed and distributed equivalent beds were worked up (and the fossils in places commingled) or locally removed. Thus at the well-known fossiliferous locality of Glaisdale there is a curious assemblage of fossils. Rhynchonellids of the *Rhyn. cynocephala*-group occur along with fossils that characterize the Pea-Grit of the Cheltenham district.

In one form or another the Dogger occurs over the whole of the moorland tract of East Yorkshire ; but in the western portion it exhibits some features that merit special attention. Thus south of Rosedale is a mass of rock about 70 feet thick at the centre, which is extraordinarily magnetic[1]; while south of the Vittoria Plantation, Bilsdale, the Dogger is nearly 50 feet thick, full of a species of *Acrosalenia*, and lies in a hollow the bottom of which is within a few feet of the Jet Rock.[2] It is of interest and significance to note that the Lower Limestone of the Edge, Painswick, Gloucestershire, is also replete with the remains of crinoids and of *Acrosalenia lycetti*.

In the Howardian Hills the Dogger does not appear as a rule to be very conspicuously developed ; but is prominent in the Derwent Valley at Kirkham, and its probable equivalent has been noticed at a very short distance below the Hydraulic Limestone in the bank alongside the railway at Castle Howard Station, where there seems also to be some representative of the Blea-Wyke Beds below.

In South-east Yorkshire no very satisfactory sections of the Dogger have been noticed, and its representative is probably thin.

The Dogger of the greater part of Yorkshire is without doubt mainly of *murchisonœ* hemera[3]. In some places part of it may be of *scissi* date, and in others it contains fossils derived from yet earlier deposits.

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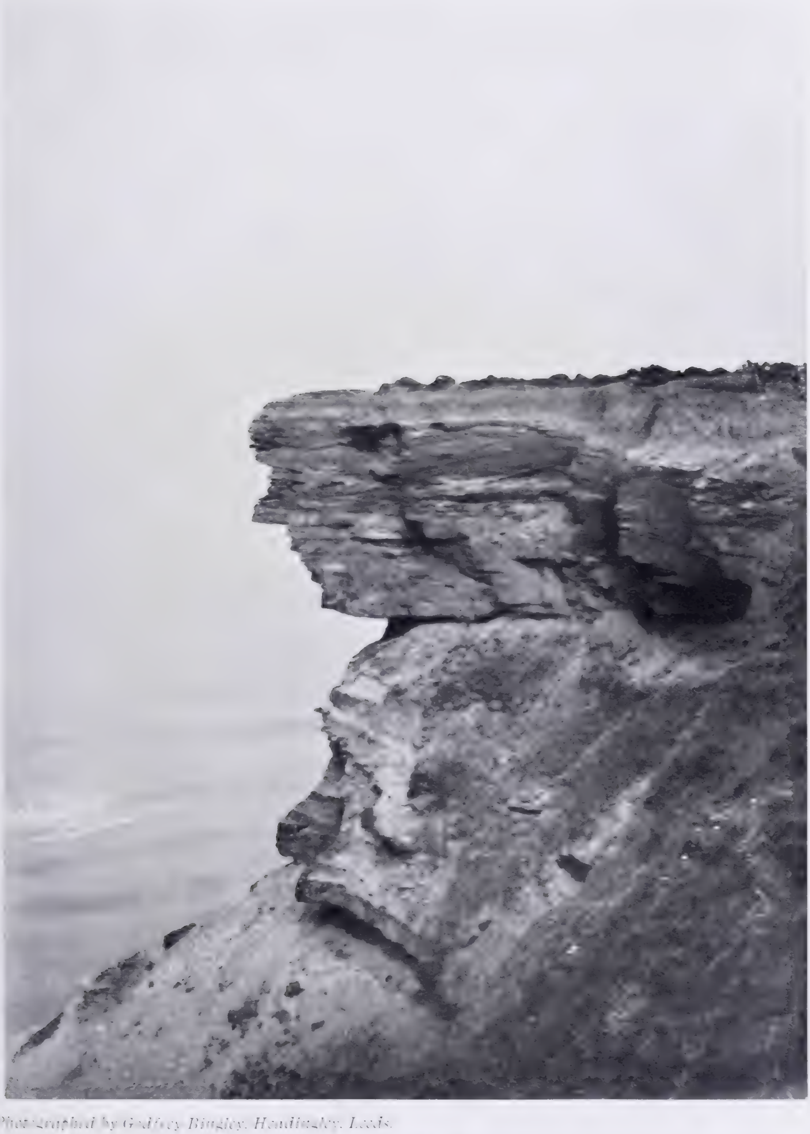
[1] "The Jurassic Rocks of Britain," Vol. I. (1892), "Yorkshire," p. 448.

[2] *Ibid.*, p. 171.

[3] It may be as well to state that I asked Dr. F. L. Kitchin if the ammonites mentioned on pages 166, 171 and 172 of the Geological Survey Memoir, "The Jurassic Rocks of Britain," Vol. I., "Yorkshire," were in the Jermyn Street Museum. He replied that they were not, and added "I do not know on whose authority the specimens were recorded."



Photographed by Godfrey Bingley, Headingley, Leeds.

Cliff near Black Nab, near Whitby.
[The Upper Lias is below and the Lower Estuarines are above.]
The Dogger is the hard bed that projects from the cliff about the level of the foam on the sea in the photograph

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APPENDIX I.—AMMONITES FROM THE SCARBOROUGH LIMESTONE.

BY S. S. BUCKMAN, F.G.S.

The strata which Quenstedt called the Coronaten-schichten, the strata of the *Blagdeni* zone (formerly *Humphriesianum* zone, in part) are only well-developed in the South of England in the neighbourhood of one locality, Sherborne, in Dorset, where they are very fossiliferous. But their preservation is very local, even close around the town.[1] Southward some 20 miles, at Burton Bradstock, there is some evidence for these strata[2]; but from Sherborne northwards to Yorkshire, a distance of nearly 300 miles must be travelled (and more along the Inferior Oolite outcrop) to find the next place where the Coronaten-schichten have been preserved. Over most of that long interval it is known that these strata have been removed by pene-contemporaneous erosion. It is just possible that the Hibaldstow beds of the Lincolnshire Limestone may be a deposit of this date;[3] but they are almost worthless to the palæontologist.

The Scarborough Limestone yields some Ammonites which fix its date—this has been long known from the species figured in Morris and Lycett's work.[4] As deposits of this date are so rare in this country, and as Mr. Richardson has submitted certain specimens which the authorities of the Scarborough Museum have kindly forwarded to him, and others which Mr. R. S. Herries kindly lent him, it may not be without interest to review the evidence.

1. SKIRROCERAS ? TRIPTOLEMUS, BEAN MS. sp.

Ammonites triptolemus, Bean MS. teste Morris and Lycett.
1850, Ammonites braikenridgii, Morris and Lycett (non Sowerby),
Great Ool. Moll., (Pal. Soc.) p. 111, Pl. XIV, Fig. 1.

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[1] Quart. Journ. Geol. Soc., 1893, Vol. XLIX, pp. 492 *et seqq.*

[2] *Ibid.* 1910, Vol. LXVI, pp. 65, *et seqq.*

[3] The Lincolnshire Limestone is so unfossiliferous that its dating is very uncertain. The following is approximate:—

HEMERÆ	STRATA
blagdeni	Hibaldstow Beds
sauzei	Kirton Beds
Witchelliæ Shirbuirniæ	Freestone Bed of the "Lings"
post discitæ	Barnack Rag
discitæ	Lincoln Silver Bed

The date of the Barnack Rag as *post discitæ* is fairly certain; and that of the Lincoln Silver Bed as *discitæ* is positive.

[4] Great Ool. Moll. (Pal. Soc.), 1850.

This species was called by Bean *A. triptolemus*, as Morris and Lycett inform us ; but they rejected Bean's name. However, the species is entirely distinct in ornament, proportions and mode of growth from *Am. braikenridgii*, d'Orbigny (= *Normannites orbignyi*, S. Buckman), and still more so from *Am. braikenridgii*, J. Sowerby. On these shells, see S. Buckman, Ann. Mag. Nat. Hist. (8), I, 1908, p. 146.

I have not seen the original specimen, nor a Yorkshire example like it, so the genus is not too certain.

2. Teloceras sp. nov.

1850, Ammonites blagdeni, Morris and Lycett (non Sowerby), Great Ool. Moll. (Pal. Soc.), Pl. XIV, Fig. 3.

This is not *A. blagdeni*, J. Sowerby, nor *A. banksi*, J. Sowerby, nor the next species : it is a form which requires a new name.

3. Teloceras coronatum, Quenstedt sp.

1886, Am. coronatus, Quenstedt, Amm. Schwäb. Jura, Pl. LXVII, Fig. 1 only.

A large specimen about 185 mm. in diameter, wholly septate, was submitted by Mr. Richardson. It is a species allied to *A. blagdeni* and *A. banksi*, but the periphery is more arched than in either ; the ornament is more of the *A. blagdeni* pattern, less coarse than in *A. banksi*.

4. Stemmatoceras subcoronatum, Oppel sp.

1849, Ammonites coronatus oolithicus, Quenstedt, Ceph., Pl. XIV, Fig. 4.

1856, Ammonites subcoronatum, Oppel, Juraf. p. 376.

A somewhat stout whorled specimen, about 140 mm. in diameter, was submitted by Mr. Richardson. As the inner whorls are much obscured by matrix the identification cannot claim to be exact ; but the specimen has the general proportions and ornaments of Quenstedt's figure.

5. STEPHEOCERAS cf. ZIETENI, QUENSTEDT sp.

1886, Ammonites humphriesianus zieteni, Quenstedt, Amm. Schwäb. Jura, Pl. LXVI, Fig. 10.

This specimen, from Mr. Richardson, is only a fragment of a whorl shewing three primary ribs dividing into six secondaries, with the knobs of junction somewhat near the inner margin. The specimen would have been about 200 to 240 mm. in diameter.

6. STEPHEOCERAS cf. PYRITOSUM, QUENSTEDT sp.

1886, Ammonites humphriesianus pyritosus, Quenstedt, Amm. Schwäb. Jura, Pl. LXVI, Fig. 4.

One fairly good specimen in the University Museum, Oxford (Phillips Coll.) from Gristhorpe [near Scarborough] about 150 mm. in diameter, agrees fairly with Quenstedt's species, but is rather more umbilicate.

DORSETENSIA ? spp.

Three specimens labelled "Cloughton G.O.," and collected by Mr. Herries, were submitted by Mr. Richardson. Two are only fragments, and the third is much broken, while its umbilicus and essential characters are much obscured by matrix : thus identifications cannot be satisfactory.

The specimens are smooth, compressed, degenerate Sonninæ with simplified suture-line ; and of the general type of smooth *Witchellia* or *Dorsetensia.* There is some likeness to *Dorsetensia romani*, Oppel sp.,[1] to *Witchellia romanoides,* Douvillé sp.,[2] and to *Dorsetensia liostraca*, S. Buckman.[3] As Mr. Herries says that he collected the specimens from the upper part of the Scarborough Limestone, which would not be earlier than *blagdeni* hemera, and as *W. romanoides* would indicate an earlier date, *sauzei* hemera, it is likely that the two other species mentioned, which are of *blagdeni* date, are the more possible identifications. One fragment may be tentatively labelled *Dorsetensia romani*, the other is some uncertain species of *Dorsetensia*, while the more perfect specimen is possibly *Dorsetensia liostraca* ; but all these identifications must be regarded as provisional. Careful removal of the matrix from the last specimen would perhaps enable a more positive statement to be made.

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[1] Pal. Mitth. 1862, Pl. XLVI, f. 2.
[2] Bull. Soc. Géol. France (3) XIII, Pl. III, f. 3, 4, 1884.
[3] Mon. I O. Amm. (Pal. Soc.), 1892, Pl. LV, f. 3-5.

Without taking into account the three specimens last mentioned, there is sufficient evidence for dating with precision the Scarborough Limestone, or Grey Oolite as it is sometimes called.

Lately Dr. Mascke[1] has from his researches in North Germany divided the deposits of the *blagdeni* hemera thus :—

Teloceras zone.
Stepheoceras zone.
Stephanoceras zone.
Stemmatoceras zone.

Of the species now dealt with *Teloceras coronatum* would indicate, in my opinion the end of the *Stepheoceras* zone or the beginning of the *Teloceras* zone, taking *Teloceras* zone as corresponding with the acme of *T. banksi*. The species of *Stepheoceras* indicate *Stepheoceras* or *Stephanoceras* zone ; but the *Skirroceras* points to something earlier.

Thus far the Ammonite evidence ; but the species of Belemnite figured by Morris and Lycett as *B. giganteus* (= *B. ellipticus*, Miller) from the Scarborough Limestone indicates as early a date as does the *Skirroceras* : it may indicate what Mascke call *Stemmatoceras* zone, something rather earlier than the true *blagdeni* zone of Dorset. On this evidence then it may be concluded that the deposit known as Scarborough Limestone began to be formed when the *Stemmatoceras* zone was being laid down in North Germany, while its ending corresponds with about the commencement of the *Teloceras* zone : there is as yet no evidence for anything later.

A word of warning may be uttered as to specimens which are said to have come from the Scarborough Limestone. The matrix of the so-called Kelloway Rock of the district (= in part, Oxford clay of southern localities) is not very dissimilar, and specimens supposed to have come from the Scarborough Limestone really belong to the much later deposit.

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[1] Die Stephanoceras-Verwandten in den Coronatenschichten von Norddeutschland; Inaug. Diss., 1907.

APPENDIX II.—COMPARISON OF THE UPPER TOARCIAN BEDS IN YORKSHIRE AND THE COTTESWOLD HILLS.

BY S. S. BUCKMAN, F.G.S.

The Yorkshire deposits of *striatuli* and post-*striatuli* date (Yeovilian) are thick, and as they shew considerable lithic difference they have received individual stratigraphical names. The Cotteswold deposits of the same date on the other hand are thin, and have little lithic difference. They have in the main received no distinguishing stratigraphical names; but have been lumped together and called the "Cephalopod Bed," a faunal term, and only lately has it been subdivided and the subdivisions called by ammonite names—also faunal terms.

Now stratigraphical or lithological terms are a great convenience; and it will facilitate comparison to coin a few for the Cotteswold rocks. With terms already in use we should then have this series:—

		STRATIGRAPHICAL TERMS	DATES OF DEPOSITION. (HEMERÆ.)
Aalenian.		Sandy ferruginous beds	*scissi*
		Hard capping	*opaliniformis*
	Cephalopod-Bed.	Top marl	*aalensis*
Yeovilian.		Second marl	*moorei*
		Ironshot stone	*dumortieriæ*
		Blackish mudstone	*dispansi*
		Yellow stone	*struckmanni*
		Linseed bed	*pedici*
		Bottom stone..	*striatuli*
Whitbian.		Yellow sands	*variabilis*

Lithic details vary; but this fairly represents what may be found just south of Stroud.

The Yorkshire strata to be compared are already named. There are:—

Dogger
Yellow Beds
Grey Beds {*Serpula*-Beds / *Lingula*-Beds}
Striatulus-Shales.

The series of Ammonites submitted by Mr. Richardson, collected partly by him and partly by Mr. S. H. Herries, with what have been examined on other occasions, give sufficient information for dating precisely the deposits between the Dogger and the *Striatulus*-Shales.

The Yellow Beds are contemporaneous with the Ironshot Stone of the Cotteswold Cephalopod Bed (*Dumortieriæ*): the Ammonites are *Dumortieria externicostata* (Branco), and *D.* aff. *multicostata*, S. Buckman.

The Grey Beds yield *Hudlestonia* spp. and *Phlyseogrammoceras dispansum* (Lycett). The latter Ammonite makes the Grey Beds equivalent to the Blackish Mudstone of the Cotteswolds (*dispansi*): but the *Hudlestonia* spp. are quoted from the *Dumortieria*-Zone of the Cotteswolds and *Dispansum*-Zone of the Yeovil district. This suggests that the *Hudlestoniæ* are on the border between the *Dispansum*- and *Dumortieria*-Beds; and that the true succession in time may be—

Dumortieria
Hudlestonia
Phlyseogr. dispansum.

This suggests a point for future investigation where the strata are thick: it is difficult to settle in the Cotteswold Hills where the beds are so thin.

Below the Grey Beds are the *Striatulus*-Shales, said to be from 50 to 70 feet thick. It has long been known that the *Striatulus*-Shales are in part equivalent to the Bottom stone of the Cotteswolds (*striatuli*); but there is no evidence yet of *Haugia eseri* nor of the fauna of the Linseed Bed (*Pseudogrammoceras pedicum* and allies). There is, however, one interesting piece of evidence among the Simpson types: sent as his *A. latescens* is a *Pseudogrammoceras* of the *quadratum* type, near to *P. subquadratum* (S. Buckman), forms of *struckmanni* date from the Yellow Stone of the Cotteswolds. The mineral condition of *A. latescens* shews that it cannot be later than the *Striatulus*-Shales; and it suggests that part of these Shales is of *struckmanni* date.

There was sent to me many years ago by the late W. H. Hudleston a specimen of *Phlyseogrammoceras orbignyi* (S. Buckman) as from the *Striatulus*-Shales. As this species is an associate of *P. dispansum* in the Cotteswolds, it would seem as if the bottom of the Grey Beds and the top of the *Striatulus*-Shales may have to be dated as *dispansi* hemera. An almost unidentifiable fragment of an ammonite from the *Serpula*-Bed of Blea Wyke (Jermyn Street Museum, 4,423) which has been quoted as *Am. aalensis* var. *moorei*[1] works out, from radial line and signs of a hollow keel, as probably a fragment of *P. orbignyi* ; but there is not much evidence in this, even if the latter identification were certain, for the specimen is probably derived.

It is now possible to put the Yorkshire and Cotteswold strata side by side.

YORKSHIRE.	COTTESWOLDS.	DATE.
Yellow Beds ..	.. Ironshot Stone	.. *Dumortieriæ*
Grey Beds ..	.. Blackish Mudstone	.. *dispansi*
Striatulus-Shales ..	Yellow Stone	.. *struckmanni*
	Bottom Stone	.. *striatuli*

The following is the Ammonite fauna of the Yorkshire strata :

Yellow Beds ..	*Dumortieria externicostata* (Branco). *D.* aff. *multicostata* S. Buckman. *Polyplectus* cf. *pietralatæ* Parisch & Viale, (not quite so triangulate). *Pseudolioceras* cf. *gradratum* S. Buckman.
Grey Beds ..	*Hudlestonia* WYKIENSIS nom. nov. *H.* cf. *wykiensis* nom. nov. *H. affinis* (Seebach). *H.* aff. *affinis* (Seebach). *Phlyseogrammoceras dispansum* (Lycett). *Pseudolioceras* sp. nov.
Striatulus-Shales	*Pseudogrammoceras latescens* (Simpson). *Phlyseogrammoceras orbignyi* (S. Buckman). *Pseudolioceras compactile* (Simpson). *Grammoceras striatulum* (J. de C. Sowerby). *G. toarciense* (d'Orbigny).

HUDLESTONIA WYKIENSIS, nom. nov. The new name is given to *H. sinon*, S. Buckman (non Bayle), Mon. Inf. Ool. Amm. (Pal. Soc., 1889, p. 227, Plate XXXVIII, fig. 13-16). The identification was only provisional, based on one poor specimen.

The omissions from the list of Yorkshire species of Ammonites are noticeable. There is no evidence yet of any of the *moorei*, *aalensis*, *opaliniformis* or *scissi* ammonite fauna : there is reason to suspect that some of these deposits are absent, unless they be found in the base of the Dogger.

There is yet no evidence of any species of *Hammatoceras*, which is associated with *P. dispansum* in the Cotteswolds. It suggests that the association in the Cotteswolds is deceptive, and that they really do not occupy the same beds when strata are thick: that they are not truly contemporaries.

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[1] Rastall, Quart. Journ. Geol. Soc. LXI (1905), 414; Strangways, Jur. Rocks Britain, I, Mem. Geol. Surv., 1892, p. 152.

The following is the full Ammonite sequence that has been noted in the Cotteswolds and South England[1]:—

Dumortieria
Hammatoceras insigne, etc.
P. dispansum
Pseudogr. struckmanni
Haugia eseri
Grammoceras striatulum.

The Yorkshire strata if carefully examined may prove this sequence, which is more elaborate than that of the Cotteswolds alone: they may add to it.

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[1] See Buckman and Wilson, Dundry Hill, Quart. Journ. Geol. Soc., Vol. LII. (1896), p. 688. note 2.

APPENDIX III.—NOTES ON SOME YORKSHIRE ECHINOIDS.

BY E. TALBOT PARIS, F.C.S.

I. INTRODUCTION.

The echinoids on which the following notes are based are in the collection of Mr. R. S. Herries, F.G.S., and were obtained by him from the Estuarine Series on or near the Yorkshire coast.

The mode of preservation of the specimens renders the identification of species—and sometimes of genera—a matter of some difficulty, many of the specimens being internal casts, while well-preserved portions of the test are extremely rare.

The specimens examined have, with a single exception, been obtained from one of three horizons, namely, the Dogger, Millepore-Bed, or Scarborough Limestone.

The following table indicates the species which have been identified and the horizons at which they occur.

NAME OF SPECIES.	Dogger.	Lower Estuarines.	Millepore-Bed.	Middle Estuarines.	Scarborough Limestone.	Upper Estuarines.
Acrosalenia lycetti Wright	*					
Cidaris bouchardi Wright	..	..	*			
Polycyphus deslongchampsi Wright	*					
Trochotiara depressum (Agassiz)	..	..	*	—	*	
Pygaster cf. *semisulcatus* (Phillips)	..	..	*			
Rhabdocidaris maxima (Munster)	..	..	..	..	*	
Stomechinus intermedius (Agassiz)	*					

There is also a portion of the test of a ? *Cidaris*, much worn, from the Yellow Beds at the Peak, Robin Hood's Bay.

The association of *Acrosalenia lycetti*, *Polycyphus deslongchampsi*, and *Stomechinus intermedius* in the Dogger confirms the view that this deposit is of *murchisonæ* hemera.

The occurrence of *Pygaster semisulcatus* associated with *Trochotiara depressum* and *Cidaris bouchardi*, in the Millepore-Bed, at a considerable distance above the Dogger, is noticeable because these species occur in beds of *murchisonæ* date in the Cotteswold area. It may be pointed out, however, that in the

Pygaster semisulcatus which has been examined from Yorkshire, the aperture was not displayed, and as the size of the aperture is the main feature that distinguishes this species from *Pygaster macrostoma* Wright, it was not possible to make an exact specific determination. It might perhaps be an intermediate form between *P. semisulcatus* and *P. macrostoma*, since the latter occurs at a much higher horizon than the former, namely in deposits of *schlœnbachi* date. Both *Trochotiara depressum* and *Cidaris bouchardi* are persistent species and range from the bottom to the top of the Inferior Oolite in the West of England.

II. NOTES ON THE SPECIMENS EXAMINED.

ACROSALENIA LYCETTI Wright.

Two examples of this species from the Dogger of Glaisdale, near Whitby, have been examined. In the West of England this echinoid attains its maximum development in deposits of *murchisonæ* date, though it has also been found in deposits of *bradfordensis* hemera.[1]

CIDARIS BOUCHARDI Wright.

The interambulacral plates of a *Cidaris* which occurs frequently in the Millepore-Bed agree precisely with those of *C. bouchardi* from the Inferior Oolite of the Cheltenham area. Unfortunately, the ambulacra are not preserved in any of the specimens I have examined from Yorkshire.

Localities :—Cloughton and Ewe Nab.

? CIDARIS sp.

A badly preserved portion of an ambulacrum from the Yellow Beds at the Peak.

POLYCYPHUS DESLONGCHAMPSI Wright.

This species appears to be fairly common in the Dogger at Glaisdale, near Whitby.

TROCHOTIARA DEPRESSUM (Agassiz).

As in the Cotteswold district this species has a considerable range, occurring both in the Millepore-Bed and in the Scarborough Limestone. The specimens from the Millepore-Bed are usually very small.

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[1] Proc. Cotteswold Nat. F.C., Vol. XVI. pt. 2 (1908), p. 164.

Records :—Scarborough Limestone, Cloughton ; Millepore-Bed, Ewe Nab and Cloughton.

PYGASTER cf. SEMISULCATUS (Phillips).

A large Pygaster which appears to be closely allied to this species has been found in the Millepore-Bed at Ewe Nab. *P. semisulcatus* is also recorded from the Millepore Bed by Dr. Wright,[1] and by the Officers of the Geological Survey.

RHABDOCIDARIS MAXIMA (Munster).

Radioles similar to that figured by Wright[2] under this name appear to be of frequent occurrence in the Scarborough Limestone at Cloughton.

STOMECHINUS INTERMEDIUS (Agassiz).

Casts of this echinoid have been procured from the Dogger at Glaisdale, near Whitby.

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[1] Quart. Journ. Geol. Soc., Vol. XVI., (1860), p. 33.

[2] Monogr. Brit. Fossil Echinodermata., Vol. I. (Supplement), p. 65 and pl. XII., fig. 11, (fig. 10 in explanation of plate). Pal. Soc.

ON THE SHELLY MORAINE OF THE SEFSTRÖM GLACIER AND OTHER SPITSBERGEN PHENOMENA ILLUSTRATIVE OF BRITISH GLACIAL CONDITIONS.[1]

BY G. W. LAMPLUGH, F.R.S., F.G.S.

WITH A NOTE BY A. STRAHAN, Sc.D., F.R.S.; AND LIST OF SHELLS BY PROF. GERARD DE GEER.

(*Read March 9th*, 1911.)

INTRODUCTION.

Last summer (1910) I was fortunately able to join the cosmopolitan party of geologists who visited Spitsbergen under the guidance of Prof. G. De Geer before the eleventh meeting of the International Geological Congress in Stockholm. From beginning to end, the journey was crowded with interest; and, as a British glacialist, I was, above all, impressed with the instructiveness of the glacial phenomena, both ancient and recent.[2] The glaciation of the Scandinavian peninsula itself, of which we saw the general outlines in our land-journeys between Stockholm and two separate points on the Norwegian coast, carries much that is enlightening in respect to our British drifts;[3] but in the present communication I shall confine myself to the experiences gained in Spitsbergen. Of the places visited there, the moraine of the Sefström Glacier was of pre-eminent interest in the elucidation of our shelly drifts, and will be more particularly described. Certain phenomena associated with the Nordenskiöld and Von Post glaciers, that are instructive in relation to our drifts, will also be noticed; and the local descriptions will be prefaced by some general observations on the Glacial conditions in Spitsbergen which are likely to be of interest to the British glacialist.[4] The route followed by the party in Spitsbergen is shown in Fig. 1.

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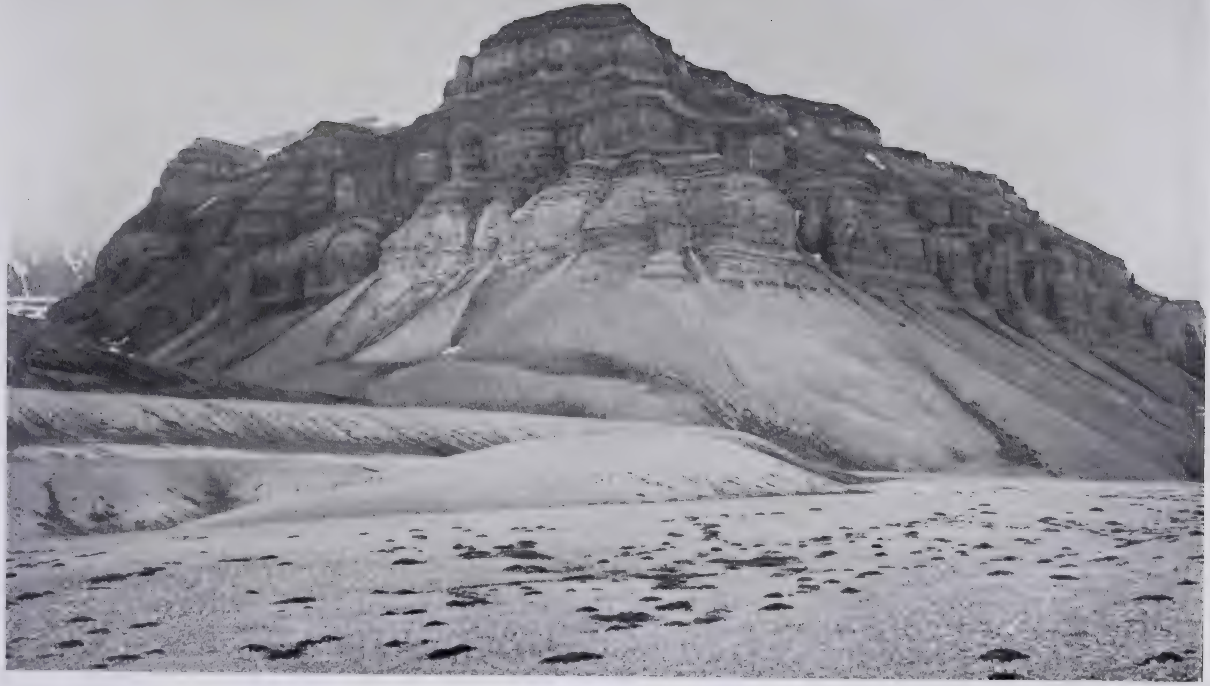
[1] An abstract of this paper was delivered at the Sheffield Meeting of the British Association, 1910 (Section C.).

[2] I have given a general account of the journey, in an article "Stockholm to Spitsbergen: The Geologists' Pilgrimage," in *Nature*, Vol. LXXXV., No. 2144 (Dec. 1st, 1910), pp. 152-7.

[3] Since this paper was written, an excellent discussion of the same subject, entitled "Glacial Features in Spitsbergen in relation to Irish Geology" has been published by a member of our party, Prof. G. A. J. Cole, in *Proc. Roy. Irish Academy, Vol. XXIX., Section B., No.* 5 (July, 1911), pp. 191-208, with 16 photographic illustrations. The reproductions of Prof. Cole's own photographs which adorn this paper afford illustrations of most of the features that I have described in the context, and his descriptions cover some points which I have not dealt with.

[4] For a fuller discussion of Spitsbergen glaciers and their general bearing on the problems of Glacial geology, *see* two excellent papers, "Contributions to the Glacial Geology of Spitsbergen," by Prof. E. J. Garwood and Prof. J. W. Gregory, *Quart. Journ. Geol. Soc.*, Vol. LIV. 1898), pp. 197-225, and "Additional Notes on the Glacial Phenomena of Spitsbergen," by Prof. E. J. Garwood, *Ibid.*, Vol. LV. (1899), pp. 681-9



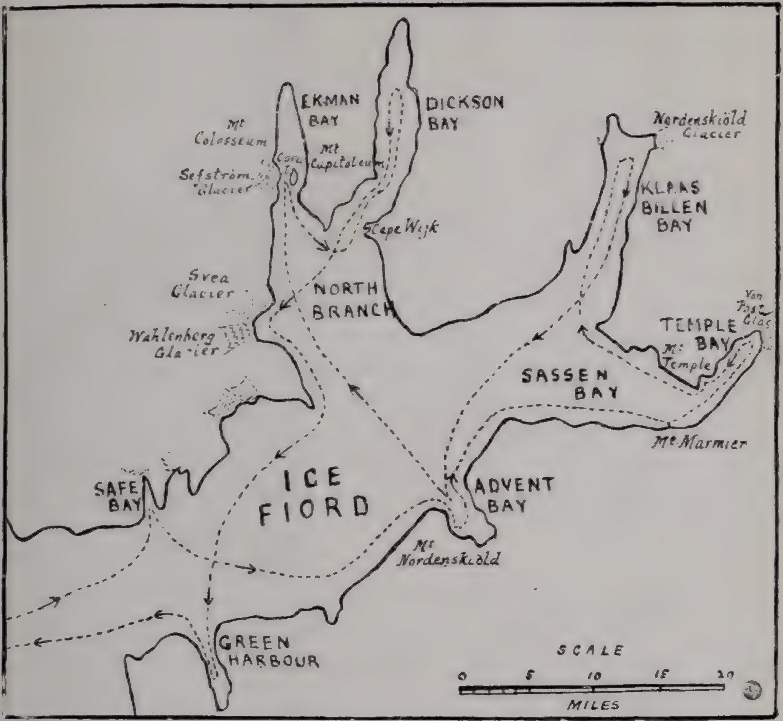
Photographed by Oscar Halldin, Stockholm. *Reproduced by permission of Prof. G. De Geer.*

Mount Temple, on the northern shore of Sassen Bay, Ice Fiord. Showing an escarpment of Carboniferous rocks, with huge talus-slopes; and with Raised Beaches in the foreground.

FIG. 1.

Sketch-map of Ice Fiord, Spitsbergen.

The dotted line shows the route of the Geol. Congress Party.



Reproduced, by permission, from "Nature," Dec. 1st, 1910.

In the short time spent at the various spots, thorough investigation was out of question, but even brief observation was sufficient to bring out many points of consequence. We had, besides, the great advantage of Prof. De Geer's previous knowledge of the ground, which he placed unreservedly at our service, although many of his results have not yet been published ; and through his guidance we were enabled to make full use of every opportunity. In recording my own observations, it will, of course, be understood that they are merely repetitions of those made previously by Prof. De Geer ; and it is with his generous consent that I bring them together in this paper. A brief account of most of the Spitsbergen glaciers that we visited, with large-scale maps of several that have been carefully measured, is contained in Prof. De Geer's "Guide de l'Excursion au Spitzberg" (Stockholm, 1910), which was placed in our hands when we started on the journey. To this publication I am indebted for all the data respecting the movements and dimensions of the glaciers.

FORMER GLACIATION OF SPITSBERGEN AND PRESENT CONDITIONS.

From the researches of the Scandinavian geologists we know that during some portion of Quarternary time, presumably during the Glacial Period of lower latitudes, nearly the whole of Spitsbergen was buried under ice, and all the great fiords, such as Ice Fiord, were filled with confluent glaciers.[1] It is remarkable, however, how scanty are the remaining traces of this great glaciation on the present tracts of bare land. The only indubitable relics of these former conditions that came under my notice in the parts that we visited were a few transported blocks, in some cases reduced to patches of frost-riven splinters, on the bare plateaus and escarpment-slopes; as, for example, on the upland above Cape Wijk.

In the long interval since this period of glaciation, there has been a time when the land stood lower than it does now, as is shown by the successive terraces of raised beach, which are strikingly displayed in most of the branches of Ice Fiord (see Pl. XXV.), where the highest beach recognized by De Geer lies about 430 feet (130 m.) above present sea-level. During this stage, the climate appears to have been less severe than now, as some of the existing glaciers which come down to the sea in the northern arms of Ice Fiord have encroached upon the raised beaches, showing that there was less ice in the valleys when these beaches were formed. Moreover, the shells contained in the lower beaches bear witness to a somewhat milder climate than that of to-day, as they include at least three species—*Litorina rudis*, *Cyprina islandica* and *Mytilus edulis*—which are not now living in Ice Fiord; and

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[1] For a good general account and résumé of the geology of Spitsbergen, including the Glacial and Post-glacial phenomena, see "Beiträge zur Geologie der Bären-Insel, Spitzbergens und des König-Karl-Landes," by Prof. A. G. Nathorst, *Bull. Geol. Instit. of Upsala*, Vol. X. (1910), pp. 261-415, in which full references are given to the previous literature.

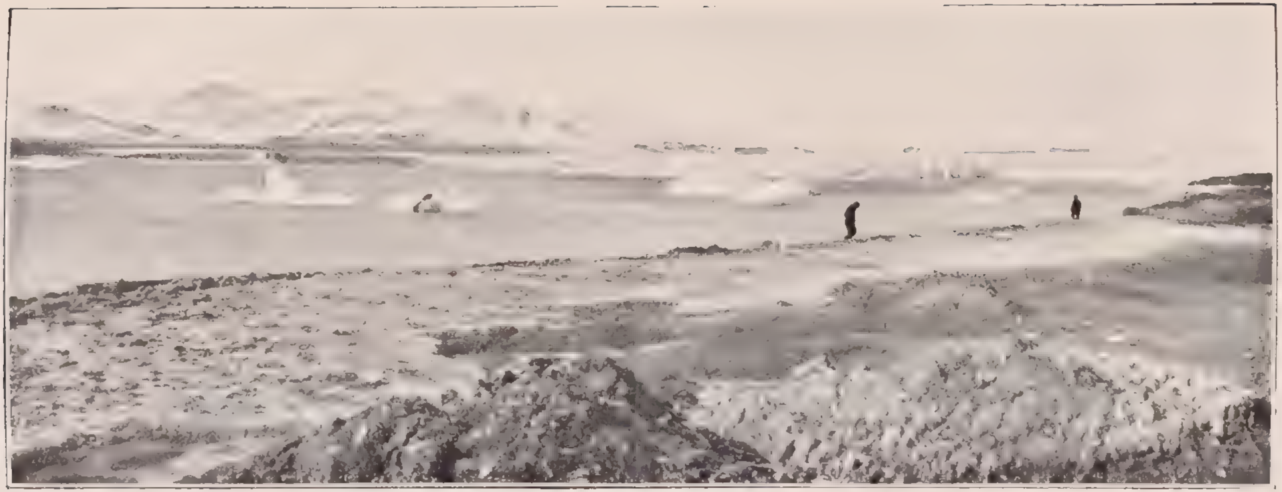

Fig. a.

Sefstrom Glacier in recession 1908, having left since 1896 the moraine in the foreground with masses of marine shells pushed up from the sea-bottom

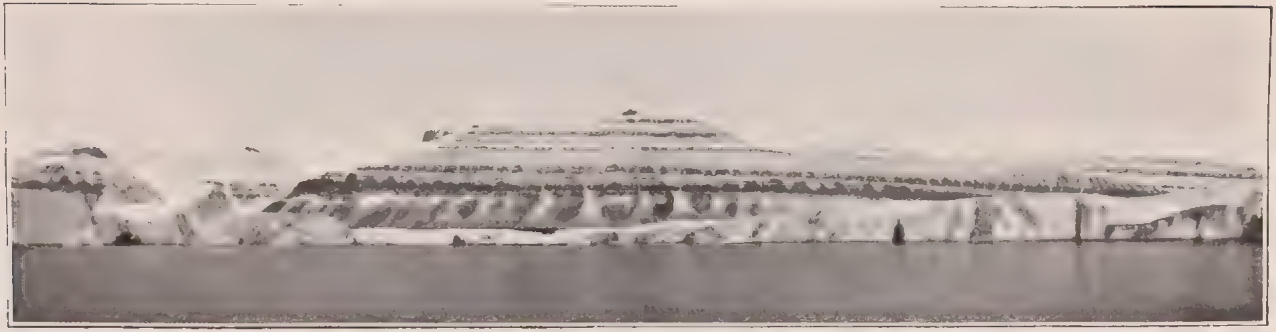

Fig. b.

Mt. Capitoleum, Carboniferous from Ekman Bay, with glacier-island in the foreground

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXVI.

(Reproduced by permission of Prof. G. De Geer, from "Guide de l'Excursion au Spitzberg.")

similar indications of less severe cold have been detected in a few plant-remains from superficial peaty deposits.[1]

For the British glacialist, it is of peculiar service to find in Spitsbergen the effect of glacial conditions on stratified rocks analogous in structure and texture to those of Southern Britain. In nearly all the other accessible regions of present glaciation the prevalent rocks are of the hard or massive type ; but over a large part of Spitsbergen, including practically the whole region bordering on Ice Fiord, the formations, ranging from Palæozoic to Tertiary, contain thick masses of shale, marl, fissile sandstones, limestones, etc., essentially similar in lithological character to the equivalent formations of Britain, from which our boulder-clays have been mainly derived. Under arctic conditions these rocks crumble down readily, so that enormous masses of talus are formed under all the escarpments (see Pl. XXV.) and even on the level plateaus, while the frosted shales slide down in mud-flows at every thaw. I was everywhere strongly impressed with the huge quantity of loose material that lay ready for conversion into glacial drift if it should be caught by a recrudescence of the land-ice ; and often the material would require very little kneading to be made forthwith into a good boulder-clay.

SPITSBERGEN GLACIERS.

In West Spitsbergen at the present time the system of glaciation is, on the whole, of the Valley or Alpine type, strongly modified, however, by the severity of the climate and consequent low altitude of the snow-fields. While many of the smaller glaciers have their origin in independent snow-basins, most of the bigger ones are fed from wide snow-fields which cover a large portion of the interior plateaus ranging between 1,500 and 3,000 feet in elevation. These extensive snowfields in many instances contain ice-sheds from which separate glaciers radiate in different directions ; but they are nearly always dominated by peaky mountain-ridges on which in the summer there is much bare rock. In North-east Land, a separate island of the Spitsbergen archipelago, the conditions are known to approximate more closely to the true Ice-sheet or Greenland type of glaciation, the major part of the land being covered by a thick mantle which obliterates all its irregularities : but in West Spitsbergen, even where the ice-mantle is broadest, its shape and slope are mainly dependent upon the outlines of the land.

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[1] See G. Andersson, "Die jetzige und fossile Quartärflora Spitzbergens als Zeugnis von Klimaänderungen" ; and A. S. Jensen and P. Harder, "Post-glacial changes of climate in Arctic regions as revealed by investigations on marine deposits" ; both in *Die Veränderungen des Klimas seit dem Maximum der letzten Eiszeit* (Stockholm, 1910).

If the winter precipitation were heavier, there is no doubt that the present climate is cold enough to foster a vast extension of the West Spitsbergen ice-fields. As the island has been, until the last two or three years, uninhabited during the long winter save by an occasional hunter or exploring party, we have few data on which to estimate the total annual precipitation. At Treurenberg Bay in the north-eastern part of West Spitsbergen, the records of a Swedish scientific expedition[1] give the precipitation for the year, August, 1899 to August, 1900, by one method of observation as 176.49 mm. (about 7 inches), and by another method as 158.03 mm. (about 6¼ inches), more than two-thirds of which fell during the summer and autumn. But it is known that the rate varies greatly in different parts of the island, and it is thought that the average may reach about 10 inches per annum. This implies that the climate is essentally arid, like that of many other high arctic and antarctic lands ; though in high latitudes aridity is disguised by the fact that the moisture falls almost entirely in the form of snow, and remains more or less permanently at the surface. In the tropics, with the same precipitation the land would be a waterless desert during most of the year.

The precipitation is greatest near the west coast, along the mountainous ridge which culminates in the north in peaks of over 4,000 feet ; and it is in this region that the glaciers are most numerous and that they most frequently descend to the sea. In the interior, many of the valleys are empty of ice or contain glaciers only at their heads or in their minor branches ; and with our present imperfect knowledge of the country, it is often difficult to understand the local conditions which have determined the presence or absence of ice-streams in contiguous and apparently similar valleys. In the country around Ice Fiord—the part of the island that we visited—the tide-water glaciers are practically confined to the northern shores and inlets of the Fiord, while on

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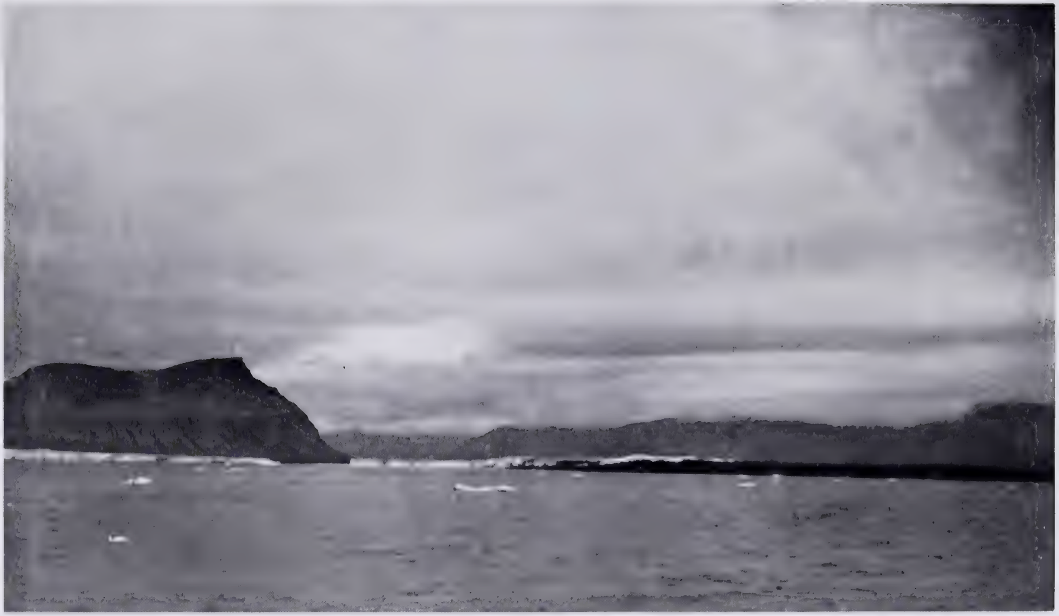
[1] *"Missions Scientifiques pour la Mésure d'un Arc du Meridian au Spizberg." Mission Suédoise,* tome II., Sec. VIII. Météorologie (1904), pp. 214-5.



Photographed by Prof. R. S. Tarr. *Reproduced by his permission.*

Looking north through the strait between Cora Island (on right) and Sefström Glacier (on left), showing detached snout of glacier adhering to island.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXVII.

its southern side the valleys are nearly or quite empty. Ice Fiord runs eastward into the land for about 60 miles, with a breadth varying between 5 and 15 miles, and with several deep arms or 'bays' branching northward and southward from it, of which the northern are the longer (see Fig. 1). The tide-water glaciers of its northern bays include several that have particular interest for the glacialist, and of first importance among them is the Sefström Glacier of Ekman Bay.

SEFSTRÖM GLACIER.

Simply as a spectacle, the Sefström Glacier is most impressive, both in itself and in its splendid setting (Pl. XXVI.). Bold and shapely mountains, composed mainly of Carboniferous rocks, rise above it on either side—Mt. Colosseum (1,970 ft.) on the north ; Mt. Bertil (2,040 feet) on the south—while the wonderful front of Mt. Capitoleum (2,790 ft.) with its exquisite sculpturing towers up majestically on the opposite side of the narrow bay. The ice-cliffs of the glacier are constantly breaking away with uproar and commotion into the sea, so that the bay is dotted with pale blue floes of fantastic shape that drift slowly outward with the tide. Its front upon the sea is about 4½ miles wide, and its seac-liffs at their highest reach nearly 300 feet.

As the result of recent studies, we know that several of the Spitsbergen glaciers—perhaps all—are subject to spasmodic fits of rapid and tumultuous advance, alternating with longer intervals of retreat and ablation during which they become relatively stagnant. Prof. De Geer has traced the history of such movements in several cases.[1] In describing them to us personally he suggested that the changes may be due to the inadequacy of the annual snowfall to maintain a constant flow in cases where the gradient of the glacier is gentle, so that the accumulated load of several years may be required to overcome the rigidity of the ice ; but when the limit is overpassed, a phase of active movement is started, and may go on vigorously until the extra load is wholly discharged and the stage of quiescence is again reached.

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[1] See "Guide de l'excursion," etc. (*op. cit.*), pp. 13-20, with large-scale ($\frac{1}{50000}$) ground-plans of Von Post, Nordenskiöld, Sefström, Wahlenberg, and Goës Glaciers.

The Sefström glacier affords the best-known instance of this rapid fluctuation.[1] When first examined by Prof. De Geer in 1882, it ended well within its own inlet, a westerly branch of Ekman Bay, with its sea-front about 2 miles distant from the waters of the main fiord. At this time it was flanked by a broad outwash plain of gravel and sand, which formed the side of the inlet up to the foot of the mountains, only the central portion of the glacier ending in the sea (see Fig. 2).

When re-examined fourteen years later, in 1896, it had undergone an astonishing change. The glacier had filled the bottom of its valley right up to the hills, burying the outwash plain, obliterating the inlet, and bulging out in a broad expanded lobe into Ekman Bay so far that its end had reached the western side of Cora Island, a small low islet lying barely a mile distant from the opposite or eastern side of the bay. The distance covered by this advance was rather more than 4 miles. That its spurt was by this time over, and that recession had already set in, was seen from the condition of another islet, Chert Island, near its southern margin, which showed evidence of having been completely overwhelmed, but was now partly laid bare.

The recession afterwards continued ; so that when Prof. De Geer renewed his investigation of the glacier in 1908, its main front of ice-cliffs between the two islands had fallen back at least a mile and a half, leaving an open anchorage for the ship at a spot where there was ice up to 300 feet above sea-level in 1896. It had broken back with a very irregular front, owing mainly, no doubt, to variation in the depth of the sea ; and the end which had been pushed on to Cora Island, being firmly aground in shallow water, still remained in position, but had been left isolated by the retreat of the main mass, so that there was a narrow sea-passage westward of the island between the glacier and its detached snout, bordered by great cliffs of ice on both sides. These successive developments are shown in a large-scale ($\frac{1}{50000}$) plan of the glacier prepared by Prof. De Geer for the "Guide," of which, by permission, a reduced copy is given in Fig. 2.

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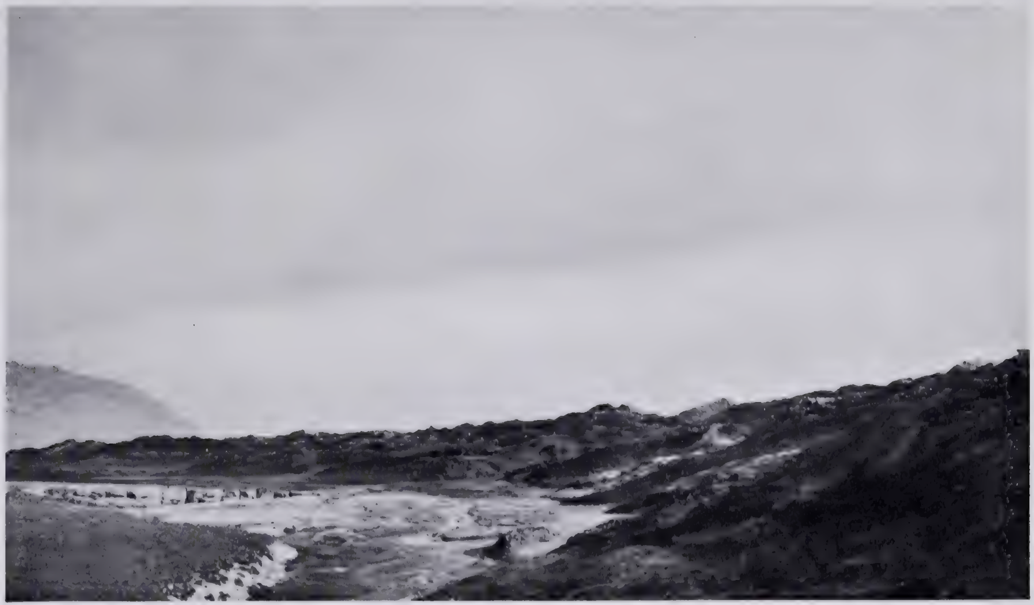
[1] Other examples, including the Von Post, Wahlenberg, and Svea Glaciers, are discussed by Prof. De Geer in the "Guide" (*op. cit.*). Nordenskiöld, many years ago, found similar indications of rapid advance among the glaciers of Bell Sound ; *Geol. Mag.* dec. II., Vol. III. (1876), p. 18. Lamont in 1860 described an abandoned shelly moraine off the end of a glacier in Stor Fiord, *Quart. Journ. Geol. Soc.*, Vol. XVI., p. 431 ; and Feilden has recorded a similar moraine occurring in Green Harbour, *Glacialists' Mag.*, Vol. II (1894), p. 1. Garwood and Gregory's account of the Booming Glacier, *Quart. Journ. Geol. Soc.*, Vol. LIV. (1898) p. 207-8 is another illustration of an active Spitsbergen glacier.

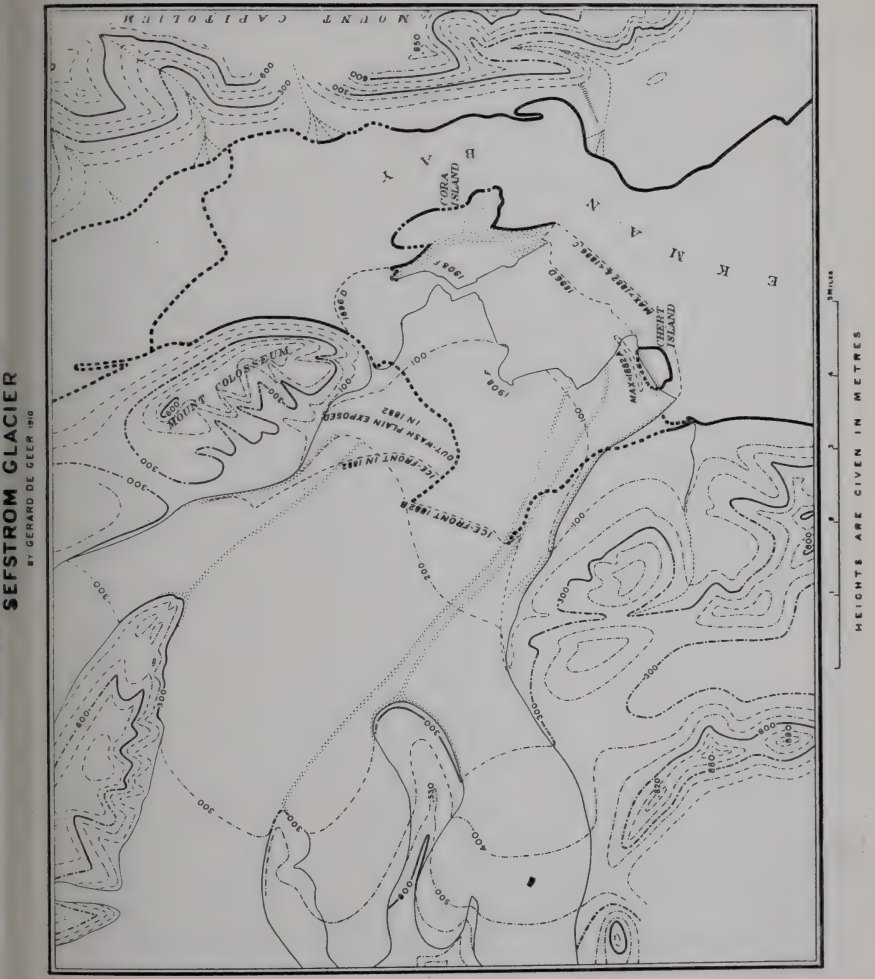


Photographed by Prof. R. S. Tarr. *Reproduced by his permission*

Eastern side of the moraine on Cora Island, looking south from near northern end. Moraine on right ; bare rocky land on left : Mt. Capitoleum in background.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXVIII.

Fig. 2.


SEFSTROM GLACIER
BY GERARD DE GEER 1910
MOUNT CAPITOLIUM
BAY
CORA ISLAND
EKMAN
CHERT ISLAND
MOUNT COLOSSEUM
OUT-WASH PLAIN EXPOSED IN 1882
ICE-FRONT IN 1882
ICE-FRONT 1882
MAX. 1882
MAX. 1882 & c 1896 C
1896 D
1908 J
5 MILES
HEIGHTS ARE GIVEN IN METRES
100
200
300
400
500
600
820
850
880
890

By last August (1910) there had been further recession, and the waterway west of Cora Island had grown broader ; but the detached remnant of the glacier, though greatly diminished by melting and undermining, still clung to the island, as shown in Pl. XXVII.

As the result of this glacial invasion, a huge mass of morainic material has been heaped up along the western side of the island. exhibiting remarkable features now to be described.

CORA ISLAND.

In its original condition, the island was a low smooth spit, about 2 miles long by half a mile wide, composed of Carboniferous rocks (chiefly limestone) partly covered with raised beach. There is no evidence that, until the recent invasion, it had ever been covered by ice since its emergence from the sea after the period of the raised beaches. All the charts dating before 1890 show it as surrounded by water ; therefore its state in 1896—the year of Prof. De Geer's observations—excited the surprise and interest of another explorer, Mr. A. Trevor-Battye, who had accompanied the expedition of Sir W. M. Conway to Spitsbergen and made an independent journey up Ekman Bay. His account of the island in that year is as follows[1]:—

> " Upon our Admiralty chart a large island is marked to the north of Ekman Bay, but for this I looked in vain, for reasons which shall presently appear. . . .
>
> " . . . Early in this exploration I was able to solve the mystery of the undiscoverable island. The Splendid [= *Sefström*] Glacier is advancing at a rapid rate. It now presents three fronts to the sea, a south-western, a south eastern, and an eastern front. From these two latter faces the glacier rises in a jagged area of seracs. Between the south-western and the south-eastern faces an apex juts boldly out into the sea, and at the time of our visit [*July*, 1896] two immense pinnacles reared themselves from the water, all but separated to their bases from the main mass. This double face of seracs, pushed from behind and undermined by the waves, is constantly falling, so that approach in a boat would be a dangerous experiment. The whole of the sea west of the

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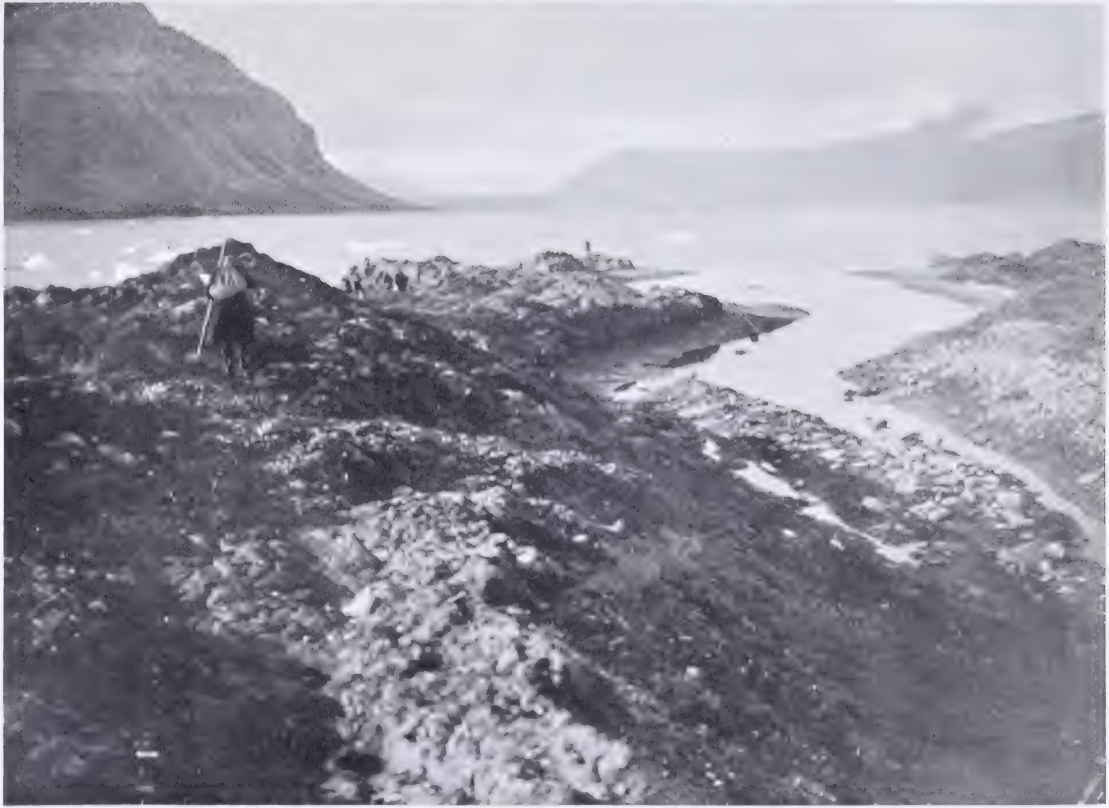
[1] " The First Crossing of Spitsbergen," by Sir W. M. Conway (*Dent & Co., London*),1897, pp. 243, 249-50.



Photographed by Oscar Halldin, Stockholm. *Reproduced by permission of Prof. G. De Geer.*

North end of the moraine on Cora Island.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXIX.

large island [*Cora Island*], shown by the survey to have existed there not twenty years ago, is now filled by the advancing glacier. More than half of the island is also overspread. *Without moraine, without dirt or discoloration, the glacier is pouring over it, and great seracs lie there, separated only, or barely separated, from the flowers and the grasses by the clear stream their drip has formed.* [Not italics in original.] A phenomenon more striking than the contrast of the green island with the icy boulders strewn along it, and the grim whiteness which rises so suddenly behind, would be hard to conceive."

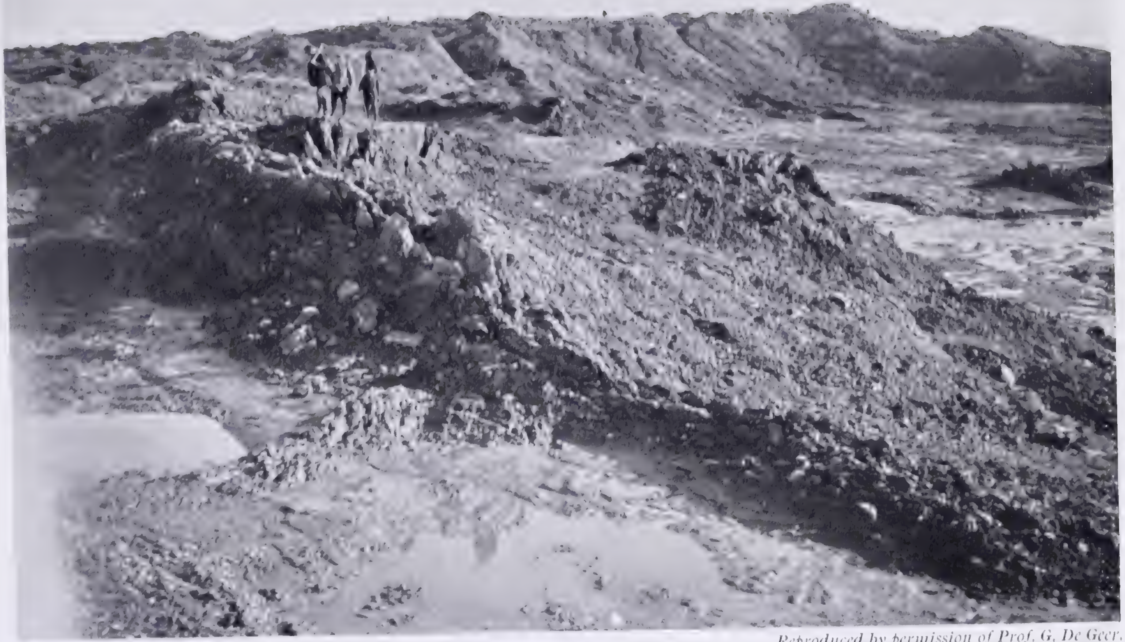
From this account it appears that the great moraine now visible was all actually hidden beneath the glacier in 1896. This moraine has doubled the size of the island, and stretches from north-west to south-east in a massive bow nearly three miles long and half a mile wide at its broadest. The convexity of this bow impinges upon the bare island (see Pl. XXVIII.) ; its concavity is still partly filled with the detached remnant of the glacier ; and its two ends run out into the sea, north and south, as tapering spits (see Pl. XXIX., which shows the northern spit).

Our ship steamed up the sound between the present main front of the glacier and the new part of Cora Island on August 7th ; and we landed by small boats, first at the northern, and afterwards at the southern extremity of the moraine, spending several hours ashore upon it—long enough to grasp its principal features, though not long enough to study all its details.

The moraine is composed almost entirely of red clay, intermingled rather sparsely with boulders and with a multitude of marine shells. This material is heaped up into a series of rude confused ridges running in general parallelism with the outer margin of the moraine, but sharply broken by many cauldron-shaped hollows and in a few places by small transverse valleys. The cauldrons range from a few yards to 200 or 300 yards in diameter ; their sides, sometimes 30 or 40 feet high, are steep and crumbling ; and their floors were covered, when we saw them, with muddy water or with sloughs of soft red mud (Pl. XXX.). Their subsidence and the crumbling of their walls were evidently in many cases still in progress, and the presence of oozing muddy pools in them confirmed the supposition that they were due to the melting of patches of ice concealed under the moraine. At its highest part, I estimated that the moraine rose at least 70 or 80 feet above sea-level; but it is possible that this height may include some buried ice, and may be reduced when the ice is all melted. On the other hand, in estimating the thickness of the morainic accumulation, allowance must be made for the original depth of the sea in the part now added to island ; and it seemed likely that, where thickest, the transported material might be 60 to 100 feet from bottom to top.

From the southern end of the moraine I followed the course of the ridges northward till opposite the place where the mass of unmelted ice still hung to the western side of the island, and I tried then to reach this ice. But the impassable cauldrons increased in numbers and size around its margin, and I failed to find a way across the maze in the time at my disposal. From a distance of 300 or 400 yards, however, I could see (with the aid of field-glasses) that the morainic clay was curiously entangled with the ice, apparently filling crevasses or dike-like gaps in it, which were prolonged in crumbling ridges where the supporting walls had melted or had been withdrawn. Some of our company, including Dr. A. Strahan and Prof. R. S. Tarr, were more fortunate in finding a safe way along the western shore right up to the ice-cliffs, and they saw that wedges of ice were present in places beneath masses of the morainic clay. I am indebted to them for permission to reproduce some photographs showing this condition (Pls. XXXI. to XXXIV.), and to Dr. Strahan for the following description of the phenomena :—

> "The cauldrons referred to by Mr. Lamplugh became larger and more abundant as the ice was approached, and the intervening ridges, along which alone a passage through the maze could be effected, became more dilapidated. On reaching the margin it became clear that the morainic material lay, and thinned off gradually, upon a rising slope of clean ice. The margin is illustrated by Plate XXXI. from a photograph by Prof. R. S. Tarr ; the ice itself was coarsely granular and presented a gently undulating surface traversed by irregular crevasses. Each crevasse had been filled up with boulder-clay, and the melting of the surface had left these 'casts of crevasses' projecting like ruined walls, or still more like igneous dikes. Plate XXXII. was taken from a point farther up on the ice-



Photographed by Oscar Halldin, Stockholm. *Reproduced by permission of Prof. G. De Geer.*

Part of the moraine on Cora Island; ridges of red shelly boulder-clay and muddy hollows.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXX.

slope than Plate XXXI. and shows the wet surface of the ice crossed in all directions by 'casts of crevasses.' The subject of Plate XXXI. is included in the left-hand distance, but is not easily distinguishable. The ice-cliff of the Sefström Glacier and the arm of the sea by which it is separated from Cora Island are shown. These two photographs face southwestward.

"A second photograph (Plate XXXIII.) was taken from the same spot as Plate XXXII., but looking eastward. It shows in the foreground the coarsely granular character of the ice and a good example of a 'cast of a crevasse.' A slight depression in the ice farther away holds a pool of water, and beyond this again the moraine which rests on the central part of Cora Island is visible. The mountains in the distance form part of the Mt. Capitoleum range.

"Plate XXXIV. shows the ice cliff at the point where the ice passes under the moraine. The ice is about 50 feet thick, and at its foot, in a deep shadow due to undercutting by the sea, it was possible to see that it rested upon boulder-clay, though the spot was inaccessible. The ice was clean from top to bottom, but that it was underlain by boulder-clay at this spot, and overlain by it close by (Plate XXXI.) was clear."

A. S.

These observations show that the boulder-clay was not pushed forward simply as a separate entity in front of the glacier, but was to some extent actually picked up and entangled with the ice so that it became part and parcel of the advancing glacier. Further, since Mr. Trevor-Battye in his description particularly notes the absence of morainic matter in the ice that he saw on the island, it appears that the transport of the clay was effected by unseen lower layers of ice. When its bottom impinged upon the rising bank which forms the basis of the island, the glacier evidently ploughed up the soft sea-floor and incorporated large masses of the material in its under part. This load was carried forward to the limits reached by the glacier ; and if the forward movement had continued, there is no reason to doubt that a large portion would have been transported as far as the lower layers advanced. The case is a clear illustration of the method by which marine detritus may be carried over the land during progressive glaciation.

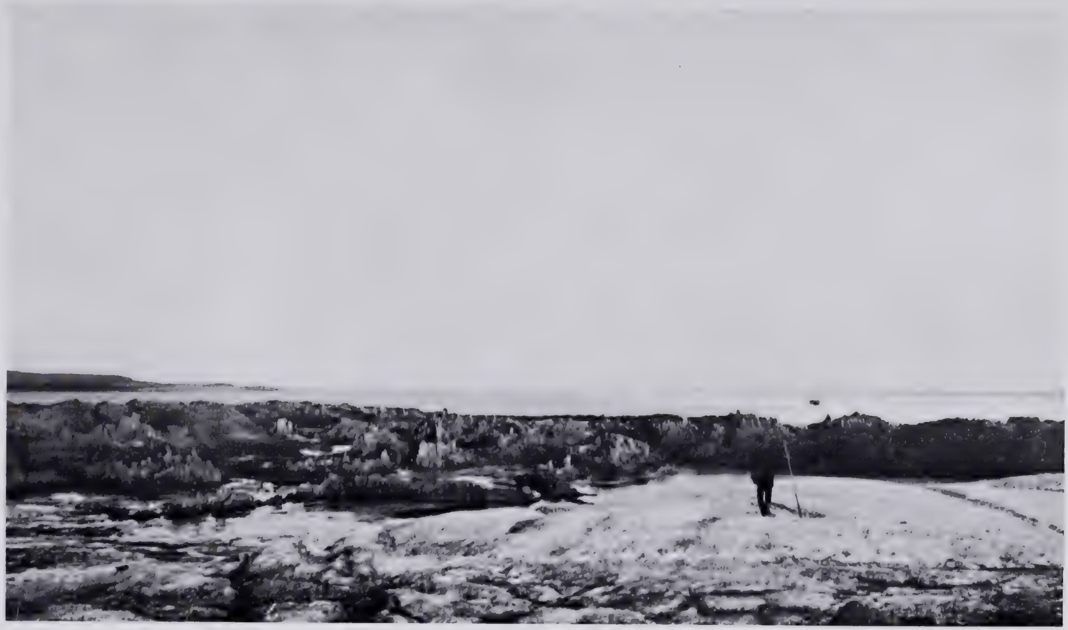
Further description of the Moraine.

The red clay of the moraine has been derived mainly from the disintegration of the red Devonian rocks—marls and sandstones—which underlie the bottom of the fiord and rise above sea-level to the north and east of Cora Island. The waters of Ekman Bay are deeply tinged, especially in the neighbourhood of the glaciers, with red mud brought in by streams; and this material must be deposited in quantity on the sea-bottom. Some of the clay of the moraine may have been derived directly from the solid rocks by glacial abrasion, but certainly the greater part has come from the muddy deposits of the fiord. So far as I saw, however, there was no sign of lamination or stratification in the mass; if any such structure existed before transport, it had been obliterated.

I have it in my notes that the colour of the clay seemed to me "a little redder than the Purple Clay of Yorkshire but not quite so red as the Hessle"; and that the proportion of boulders was "about the same as in Yorkshire clays, or a little more." The clay was rather loamy and crumbling where dry—not so hard as our Yorkshire boulder clays—but was tough and sticky where wet. It was laced here and there with streaks of grey-green colour, containing crushed shale, very like the streaks one sees in the 'red band' of our Holderness drift-sections; and this seemed to imply the derivation of such portions from fresh unweathered rock.

All the boulders that I saw were from the local formations, chiefly grey and purple sandstones, limestones, chert, conglomerate, etc. Some were striated; others, about equal in number, had no striæ; and a few were angular. Many were thickly encrusted with a sea-growth of *Lithothamnion*, showing that they had lain on the bottom of the fiord; and I noticed limestone boulders with molluscan borings, like those we find occasionally in the Holderness boulder-clays. The boulders were distributed somewhat patchily, as in most boulder clays, being sometimes clustered and sometimes widely spaced. There were a few gravelly streaks and pockets in the clay, but I saw no regular stratified deposits of any kind, the scantiness of fluvio-glacial detritus striking me as remarkable and unexpected.

Save for a stray and exceptional tuft of grass the whole area of the moraine was absolutely bare; its material was likewise exposed in section in the steep walls of the cauldrons, and in the



Photographed by Prof. R. S, Tarr. *Reproduced by his permission.*

Glacier-ice on west side of Cora Island, with interspersed masses of red boulder-clay.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXXI.

low sea-cliffs at both ends of the island where it had almost exactly the appearance of a boulder-clay of the Yorkshire or Lancashire coast. The shells were everywhere abundant and conspicuous on the surface ; they were present also in all the sections that I examined, but I thought that they were more plentiful at the top than in the deeper clay—perhaps, however, only because they were less conspicuous when seen edgewise and unwashed.

The fortunate interposition of this bit of ground rising from the sea in the path of the advancing glacier has indeed presented an opportunity which is perhaps unique under existing conditions. The glacier came to land again on a low shelving coast after traversing the sea-bottom ; and I know of no other present example of this phenomenon, though we have reason to believe that it was a common condition during the Pleistocene glaciation. To me, one of the most impressive features of the moraine was its abrupt termination upon the bare ground of the island (see Pl. XXVIII. and Figs. 3 and 4).

The original low shelf of gently inclined rock and old beach-shingle forming Cora Island probably nowhere rises to more than 30 or 40 feet above present sea-level, and most of it is considerably lower than this. It supports the usual scanty tundra-growth of the Spitsbergen lowlands, this growth being continuous close up to the red clay of the moraine, and there stopping abruptly. From Mr. Trevor-Battye's description and from the height of the unmelted remnant of ice, it is clear that the glacier shot forward over the island-shelf with a dominating front rising high above the land-level. Part of its height was due to the intercalated foundation of moraine that it had dragged along ; and this foundation must have extended close up to the front of the glacier, though apparently it was hidden by higher layers of clean ice at the time of Mr. Trevor-Battye's visit.

The great moraine now marks out very closely the limits reached by the ice. As shown in Pl. XXVIII., the ridges of red clay rise up boldly above all the smooth low tundra that lay beyond reach of the invader ; and though the transported mass sinks lower towards its outer margin, it ended wherever I saw it in a very definite bank several feet in height, from which one could step in a few strides on to the undisturbed tundra.

FIG. 3.

Diagrammatic section across Cora Island to the front of the Sefström Glacier (1910).
Scale (approximate) :—Horizontal, 3 inches = 1 mile : Vertical, × 3.

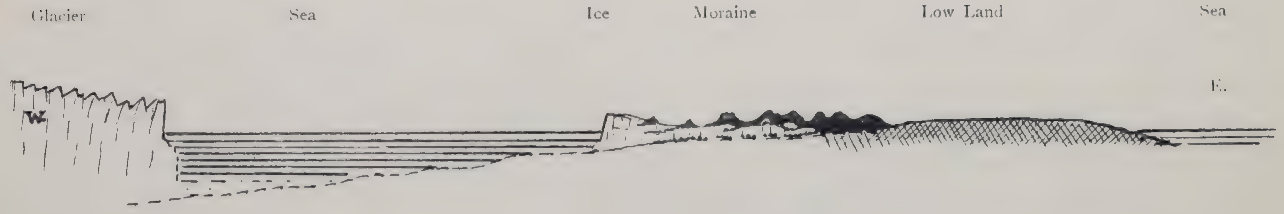
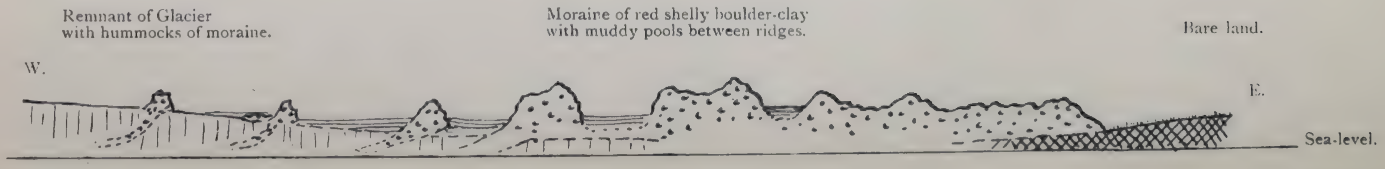
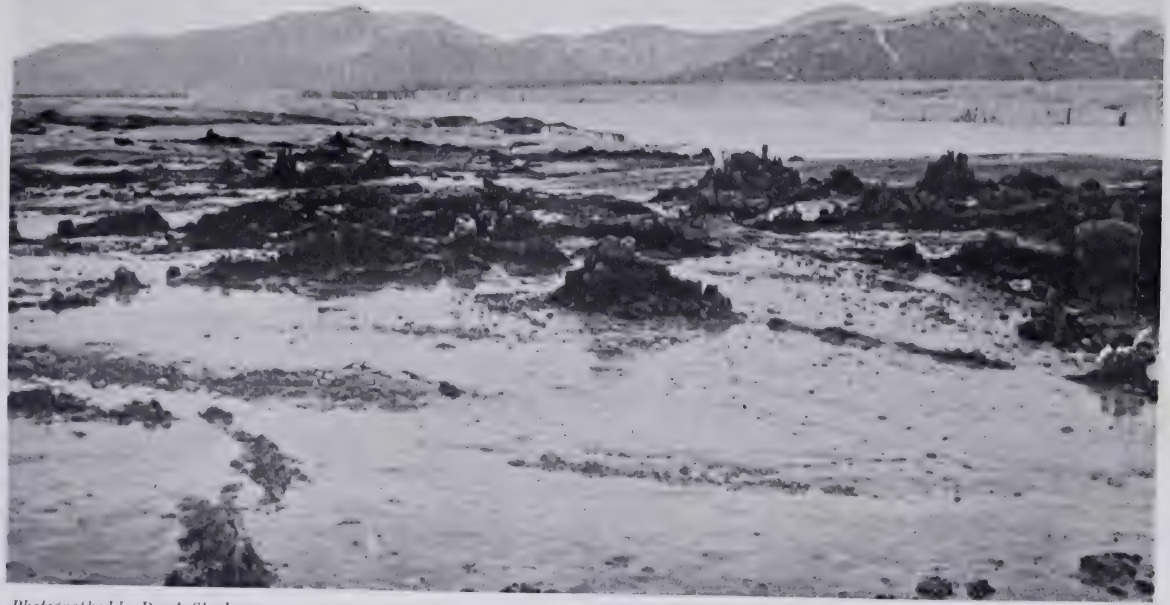


FIG. 4.

Diagrammatic section across the central part of the moraine on Cora Island.
Scale (approximate) :—Horizontal, 9 inches = 1 mile : Vertical, × 2.


Remnant of Glacier
with hummocks of moraine.
Moraine of red shelly boulder-clay
with muddy pools between ridges.
Bare land.
W.
E.
Sea-level.



Photographed by Dr. A. Strahan.

Surface of the glacier-remnant on Cora Island with incorporated masses of morainic clay: the retreating front of the Sefström Glacier in the background.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXXII.

The slope of the original surface being toward the moraine, there is now a slight depression, with the moraine on the western side, and the unglaciated land on the east. The drainage from the melting ice has followed this depression northward and southward to the sea, along the periphery of the moraine, slightly eroding its margin and still further accentuating the abruptness of its termination ; but the gradient is too gentle and the elevation too low to leave much play for erosion. In traversing, here and there, the beds of these now-dry watercourses, I was surprised by the scantiness of gravel or other water-borne sediments ; the extinct streams have doubtless carried their fine mud in suspension to the sea, and they seem to have had very little heavier material to transport.

This absence of a fringe of fluvio-glacial detritus was unexpected, as one had been inclined to regard such a fringe as an essential concomitant of an ice-border on low ground. Its absence in this case was, however, readily explained by our leader. who pointed out that very little of the drainage of the glacier could ever cross the deep trough of the fiord, and that as soon as the ice began to recede from the island, nearly all its surface-drainage would fall backward into the trough. Prof. De Geer showed us, nevertheless, a short transverse valley crossing the moraine near its northern end, which he knew to have been cut by water flowing from the glacier, as he had seen a stream issuing from the ice at this point in 1896.

The relations of the moraine to the original island are illustrated diagrammatically in Figs. 3 and 4, which are based on rough sketches that I made on the spot.

The Shells of the Moraine.

Of course, the point of surpassing interest on Cora Island to an East Yorkshire glacialist was the presence of shells in the moraine. Personally, ever since I began the study of our drifts over 30 years ago, I have been convinced that the transport of shells was effected on a large scale by the ice-sheets of the Glacial period in passing over the floors of our seas ; from time to time I had read of modern instances of the process in Norway,[1] Greenland[2] and Spitsbergen[3] ; and here, at last, I saw for myself a complete demonstration of it. The advancing glacier had acted like a great dredge ; in crossing the trough of the fiord, it had dragged the material of the sea-bottom up the slope and spread it out for investigation upon the land.[1] Moreover, it had done its dredging work so effectively that the majority of the shells had not been injured by their removal. Their state of preservation was indeed astonishing, as was also their profusion. Evidently the neighbourhood sea at a moderate depth is full of life, though the winter frosts and the formation of ice-foot along the shore render the conditions intolerable to molluscan life between tide-marks, so that usually there were few shells to be seen on the foreshore except such as were derived from elevated marine beds of the raised-beach period. But on Cora Island the beach was crowded with shells, undoubtedly derived from the moraine.

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[1] A. Geikie, "Geological Sketches at Home and Abroad" (*London*, 1882) pp. 145-6.

[2] R. D. Salisbury, "Glacial Geology." *Rep. Geol. Surv. of New Jersey*, Vol. V. (1902), p. 81.

[3] E. J. Garwood and J. W. Gregory ; also A. E. Nordenskiöld, J. Lamont and H. W. Feilden ; all in works cited in footnote on p. 222 ; and H. Backlund (Négri Glacier on east coast) in "*Missions Scientifiques pour la Mésure d' un Arc*, etc.," *Mission Russe*, tome II., Sec. IX., (1908), p. 10.

Over every part of the moraine that I traversed, the shells were present, clustered thickly in some places and thinly scattered in others ; and fragments of *Lithothamnion* were even more plentiful than the shells, sometimes occurring in twisted streaks that resembled in appearance the streaks of chalk-detritus so common in the Holderness boulder-clays. Bivalves greatly predominated, mainly species of *Astarte*, *Mya*, *Pecten* and *Tellina* ; but there was likewise a sprinkling of univalves, chiefly species of *Natica* and *Buccinum.* In many cases the epidermis was still fresh on the forms like *Astarte* which have this covering ; and a great many of the bivalves occurred with the shells closely united as in life, and in some cases with the shrivelled ligament still in position. The interior of the paired bivalves was usually filled with red clay like the matrix in which they were embedded ; in two or three instances, however, I found that the infilling material was more sandy and paler than the matrix, though the difference was not so marked as that which has been occasionally observed in the interior of shells from the Yorkshire boulder-clays. Isolated valves were common, and some of the shells were broken ; but perfect shells and paired valves predominated.

I had no time for systematic collecting, and merely filled my pocket with shells that came in my way, therefore obtaining only the commoner forms. The richness of the fauna is shown by the

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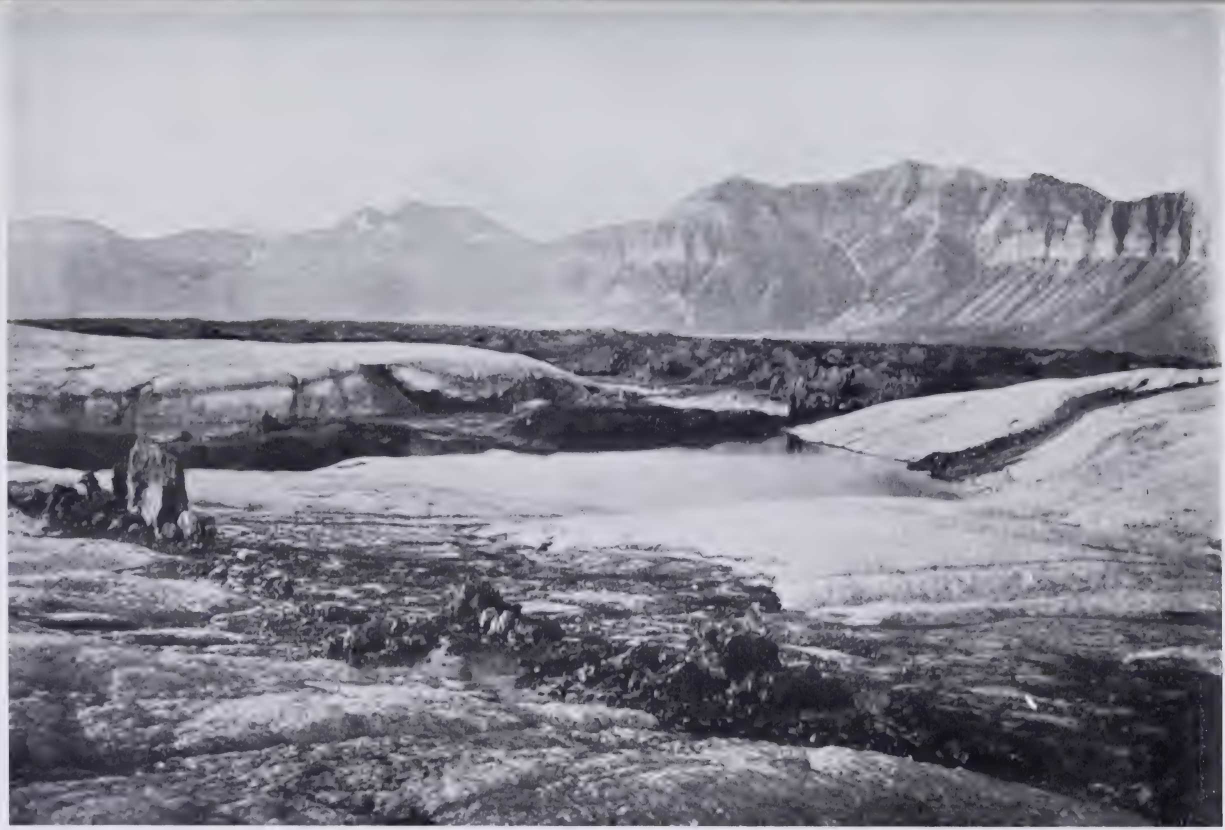
[1] [P.S. Sept. 1911.] Prof. G. A. J. Cole, in the paper cited on p 216, suggests that the material may have been transported from raised beaches on the western shore of Ekman Bay ; but the fresh condition of the shells, the medial position of the moraine in respect to the front of the glacier, and indeed all the circumstances, appeared to me to indicate that it was derived from the bottom of the fiord and not from the shores.



Photographed by Dr. A. Strahan.

Surface of the glacier remnant on Cora Island, with a dike-like ridge of morainic clay in the foreground; and the main mass of the moraine in the middle distance.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXXIII.

list given on p. 235, for which I am indebted to Prof. De Geer. My own gleaning was made up of the following species (I use the older names by which the shells are best known to British glacialists) :—*Astarte elliptica*, *Astarte borealis*, *Mya truncata*, *Pecten islandicus*, *Tellina calcarea*—all of which were very plentiful ; and I had, besides a large and perfect specimen of *Cardium groenlandicum* (a rather fragile shell), some broken valves of *Mytilus edulis*, a *Natica*, and a *Buccinum*.

This, it will be noted, is precisely such a list as we should get most easily in collecting shells from the East Yorkshire boulder-clays, except that *Tellina balthica* would take the place of *Tellina calcarea* (which is very rare in our drifts) and we should be sure of including also *Cyprina islandica* (which has likewise been found on Cora Island, but not by me).

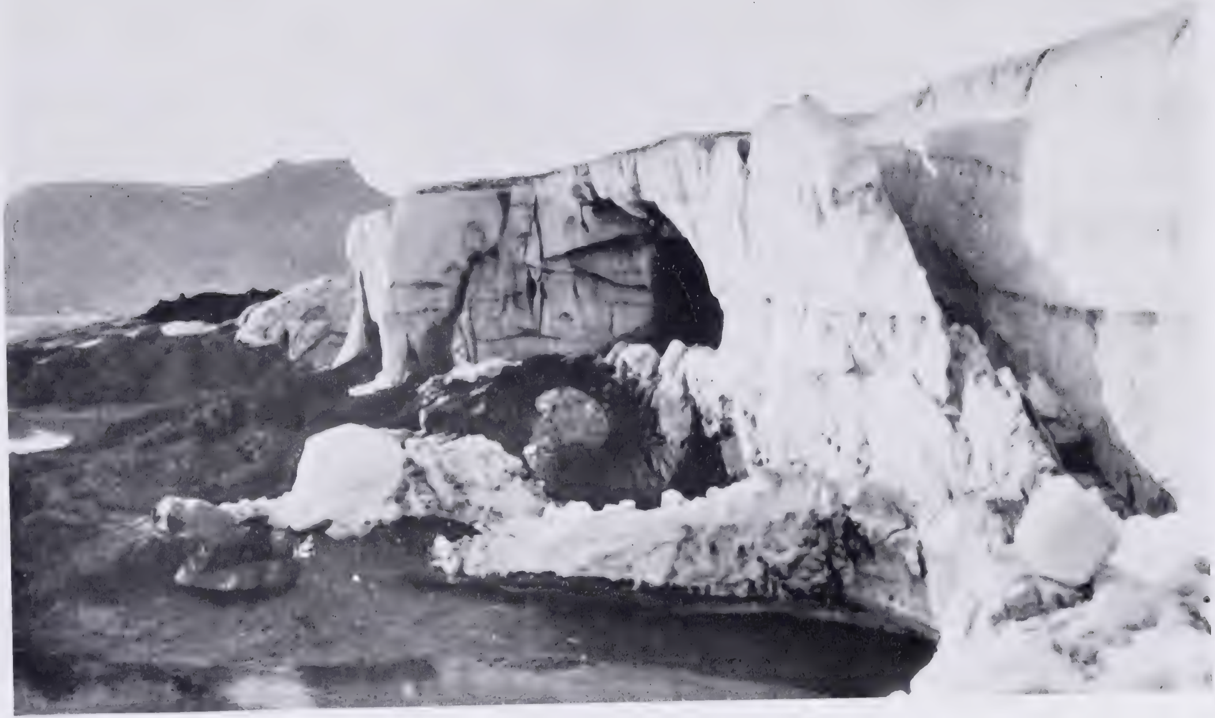
There is one strong difference, however, in the profusion of the coral-like calcareous *Lithothamnion* which I do not remember ever to have seen in our shelly drifts, while on Cora Island it was everywhere ; and some of the dead shells of the big pectens had been so thickly coated with encrusting growths, that they had the shape of small birds' nests.

The seaward front of the moraine is now being steadily wasted by the waves, and the clay is carried away in suspension while the shells and *Lithothamnion*-débris are swept alongshore to the south end of the island where they are cast upon a low curving spit, practically unmixed with any other material. This glaring white beach, shown in Pl. XXXV., is at present the best collecting-ground in Ice Fiord for shells. First the glacier did the dredging ; then the sea did the washing and sifting ; and now, as may be seen in the picture, the conchologist can do the collecting at his ease !

I have previously mentioned that there are to be found in the raised beaches around Ice Fiord certain species of shells which no longer live in its waters, and that these are regarded as evidence of a somewhat warmer climate in comparatively recent times. Five such species (classed as "Post-glacial" in the appended list, p. 235) are included in Prof. De Geer's collection from Cora Island. Their occurrence furnishes another point of analogy between the Sefström moraine and the British shelly drifts wherein there is often an admixture of species that probably lived under different conditions of depth and temperature.

It is evident that many of the shells now on Cora Island are the relics of molluscs that were actually alive just before the advancing glacier swept them from their habitat in the fiord, along with the clay deposited there. The presence of the species not now extant indicates, however, that the glacier did not merely scrape the surface of the sea-floor, but ploughed down into it ; for the muddy waters of the bay must constantly precipitate much sediment, so that the ancient shells were probably buried at some depth. The abundance of *Mytilus edulis* in the moraine shows that, whatever may have been the thickness of the overlying sediment, the ice-plough went, at any rate, deep enough to reach and transport the layers representing the by-gone period of milder conditions.

It is hardly possible to fix the exact distance that the shells have been carried, as we do not know at what stage of its advance the glacier began its dredging. Presumably the effect was greatest when the ice impinged on the rising slope of the sea-bottom near the island, in which case the distance would not be over a mile ; but if the operation began earlier, the shells may have been carried for three or four miles. The vertical uplift from the deepest part of the fiord to the highest part of the moraine may have been about 250 feet ; in most cases it has probably been somewhere between 50 and 100 feet. Even with so short a journey, the marine material showed hardly any trace of its original order, except in some patches, seen by Dr. Strahan, in the portion still entangled with the ice. If the glacier had continued to move forward, the material must have been carried farther ; in fact there is every probability that some part of it would have been carried along to the farthest limits attained by the ice, and would there have been cast down pell-mell, as soon as the retreat set in. During a longer journey, however, the shells could hardly have retained their perfect condition ; they would have 'gone farther and fared worse,' becoming gradually reduced to the fragmentary and travel-worn state of the specimens with which we are so familiar in our British shelly drifts ; but in the patches of 'Bridlington Crag' of the Basement Boulder Clay of Bridlington, South Sea Landing, and Dimlington, the shells are in the same condition as those of the Sefström moraine.



Photographed by Dr. A. Strahan.

The glacier-remnant on Cora Island, surmounting, and mixed with, the shelly moraine.

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Prof. De Geer, who has got together an extensive collection of the Cora Island shells, has kindly sent me for publication the following list, not hitherto published, of the species already identified.

List of the Shells, etc., from Cora Island.

" Post-glacial and recent marine shells pushed up between 1882-96 by the advancing Sefström glacier in the great terminal moraine on Cora Island in Ekman Bay of the Ice Fiord, Spitsbergen, from depths between 0-50 meters " :—(*Signed*) " Gerard De Geer, Stockholm, 31st May, 1911."

" *Post-glacial species.*

Anomia ephippium *Lin.*
Mytilus edulis *Lin.*
Cyprina islandica *Lin.*
Litorina rudis *Maton*
Onoba aculeus *Gould*

Recent species.

Pecten islandicus *Müll.*
Crenella lævigata *Gray*
Crenella decussata *Mont.*
Leda pernula *Müll.*
Yoldia (Portlandia) arctica *Gray*
Cardium ciliatum *Fabr.*
Cardium groenlandicum *Chemn.*
Astarte borealis *Chemn.*
Astarte compressa *Mont.*
Astarte elliptica *Brown*
Axinus gouldii *Phil.*
Tellina calcaria *Chemn.*
Mya truncata *Lin.*
Saxicava rugosa *Lin.* var. pholadis.
Chiton marmoreus *Fabr.*
Tectura rubella *Fabr.*
Lepeta cæca *Müll.*
Puncturella noachina *Lin.*
Moelleria costulata *Möll.*
Margarita helicina *Fabr.*
Margarita groenlandica *Chemn.*
Natica affinis *Gmel.*
Lacuna crassior *Mont.* ?

Cingula castanea *Möll.*
Bela elegans *Möll.*
Bela bicarinata *Couth.*
Trophon clathratus *Lin.*
Buccinum glaciale *Lin.*
Buccinum tenue *Gray*
Buccinum groenlandicum *Chemn.*
Echinus droebakensis *Müll.*
Balanus porcatus *da Costa*
Serpula sp.
Spirorbis sp.
Foraminifera (especially a great Biloculina).
Ostracoda
Bryozoa
Lithothamnion (predominant)."

NORDENSKIÖLD GLACIER.

Reference has already been made to other instances of shelly moraines which have been observed in association with Spitsbergen glaciers,[1] though none appears to have been so remarkable as the Sefström example. The only other case which we saw during our recent journey was that of the Nordenskiöld Glacier.

This great glacier comes down to the sea in the eastern arm of Klaas Billen Bay (see Fig. 1), ending off with an ice-front of three miles in water nearly 500 feet deep. It has shown only minor changes since its measurement in 1882; and the extension of a series of raised beaches close up to its southern margin proves that it cannot have reached much beyond its present bounds at any time since the beaches were formed. It has slightly invaded these beaches and incorporated some of their shelly material in its southern lateral moraine. This moraine is composed mainly of very stony grey clay derived from the Carboniferous rocks. We examined it in the gully cut by a strong stream flowing from the flank of the glacier, and found a few shells, mostly in dispersed fragments and in a state of preservation very different from that of the Cora Island shells. Here, of course, there was no chance of seeing what has happened under the seaward front of the glacier; it is merely the already weathered material of the raised beach that has supplied the marine detritus to the lateral moraine.

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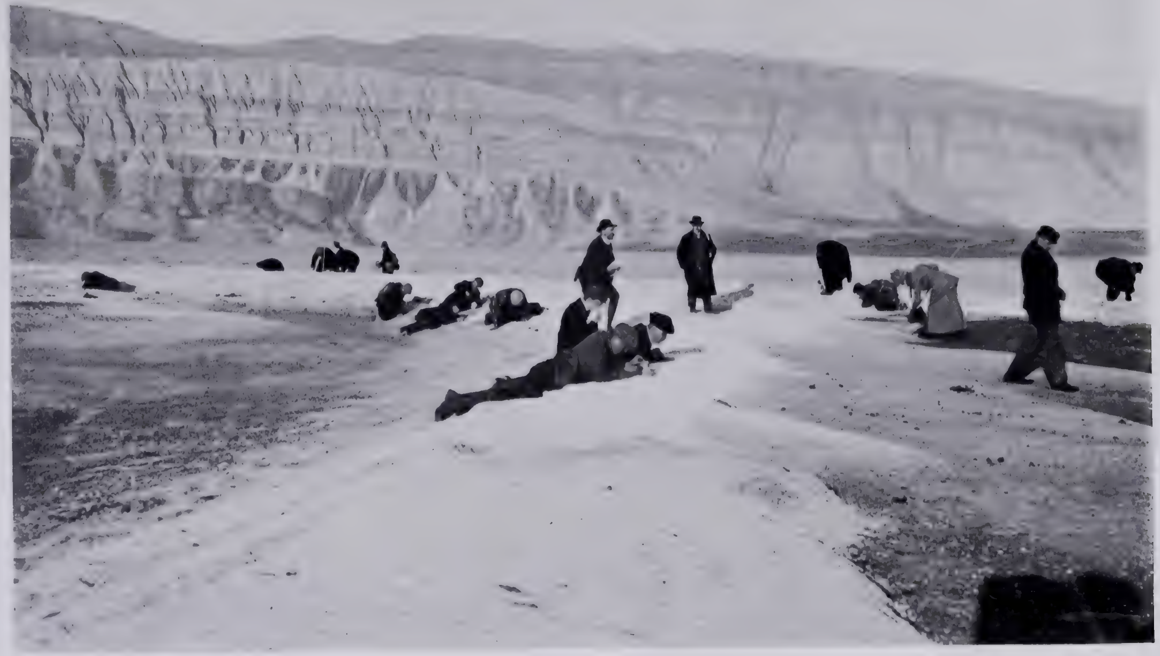
[1] See footnote references on p. 231.



Photographed by Oscar Halldin, Stockholm. *Reproduced by permission of Prof. G. De Geer.*

Spit at south end of Cora Island, composed of lithothamnion-débris and shells derived from the moraine. Mt. Capitoleum in the background.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXXV.

Nevertheless the instance was instructive, in showing how readily shells and other beach-material are incorporated with glacial deposits when they come within reach of moving land-ice. It was difficult, in some of the sections, to tell where the raised beaches ended and the moraine began.

VON POST GLACIER.

Another tide-water glacier that we visited in Ice Fiord was the splendid Von Post Glacier at the head of Temple Bay (Pl. XXXVI.). The sea-front of this glacier is about 2½ miles wide, and rises to nearly 300 feet above water. A large-scale ($\frac{1}{50000}$) plan published by Prof. De Geer in the "Guide de l' excursion" shows that the glacier has been in slow retreat since 1883. Before then, it had fallen back nearly a mile from an earlier maximum, as indicated by its lateral moraines which extend for about 1½ mile beyond its present front. Its terminal moraine is submerged under the waters of the inlet; but the lateral moraines line both shores of Temple Bay, and their internal composition is clearly revealed in wave-cut cliffs.

As seen in the cliff-sections, 10 to 50 feet high, the lateral moraines have a homogeneous structure. They are composed of rather sandy red clay, sufficiently compact to be traversed by vertical joints and to break down from the cliffs in big slices, after the fashion of our British boulder-clays. On both sides of the bay we landed at the foot of these cliffs which were strongly reminiscent of similar cliffs known to me on the coasts of North-east Yorkshire, the Isle of Man, and other parts of our Islands. We examined some parts of the moraine that had been exposed by the recession of the ice since 1883.

The clayey matrix was studded with numerous boulders of varied size, many of them worn and highly glaciated, and of diverse composition, including many igneous and metamorphic rocks, along with grey and red sandstones, conglomerates, chert, Carboniferous limestones and other sedimentary rocks. The end of the glacier lies in a region of grey Carboniferous strata, with no older formations visible in the neighbourhood ; but it is known that more ancient rocks crop out to the northward, among the ice-fields of the interior ; and it is evident that the glacier has transported most of the material of its moraines, including the red clay and the igneous and metamorphic boulders, from its concealed bed and from its upper basin. The absence of shells or other marine detritus showed that in this case we had to deal with the land-spoil of the glacier and not with re-distributed marine deposits.

Though the seaward cliffs of the moraine, so far as I saw them, were composed throughout of this red boulder-clay, there must have been places farther from the sea where grey Carboniferous detritus of local origin was mixed in preponderant quantity with the red drift, as the morainic rock-waste on the surface of the ice at the southern flank of the glacier appeared to be mainly constituted of such local material. In traversing some moraine-covered ice on this flank, I noticed that amid the sheets of angular grey Carboniferous rubble there were streaky patches, here and there, of dirty red ice, carrying some well-glaciated boulders of the ancient rocks. It was clear that at these places the deeper moraine was somehow being brought up to the surface of the glacier. Fortunately, the moraine-charged ice near the southern edge of the glacier was notched by a deeply-cut stream-gully, accessible from the shore. The section in the walls of this gully near its mouth exhibited moraine-laden ice bent into sharp upward curves and sigmoidal contortions (see Pl. XXXVII.); and in one place a belt of ice sweeping boldly upward was charged with red mud and scratched stones, while above and below the ice was charged with the dull grey local débris. The section, in fact, beautifully illustrated the conditions, described by Garwood and Gregory in other Spitsbergen localities, whereby the lower layers near the end of a glacier are deflected upward along shear planes and brought to the surface.[1]

If it came about that this glacier received no further accession, so that it became stagnant and now melted down without movement, it would leave as a residue, in the part we saw, two very different kinds of drift : the lower, a red clay with far-transported stones ; the upper, a grey rubbly clay with a preponderance of local stones, mostly unglaciated : and the two would show, in some places, complicated inter-digitation and banding.

In our British drifts it has often been deduced that a difference of composition in successive beds of boulder-clay implies separate periods of glaciation; but the evidence of the Von Post moraines shows that the deduction is unsafe.

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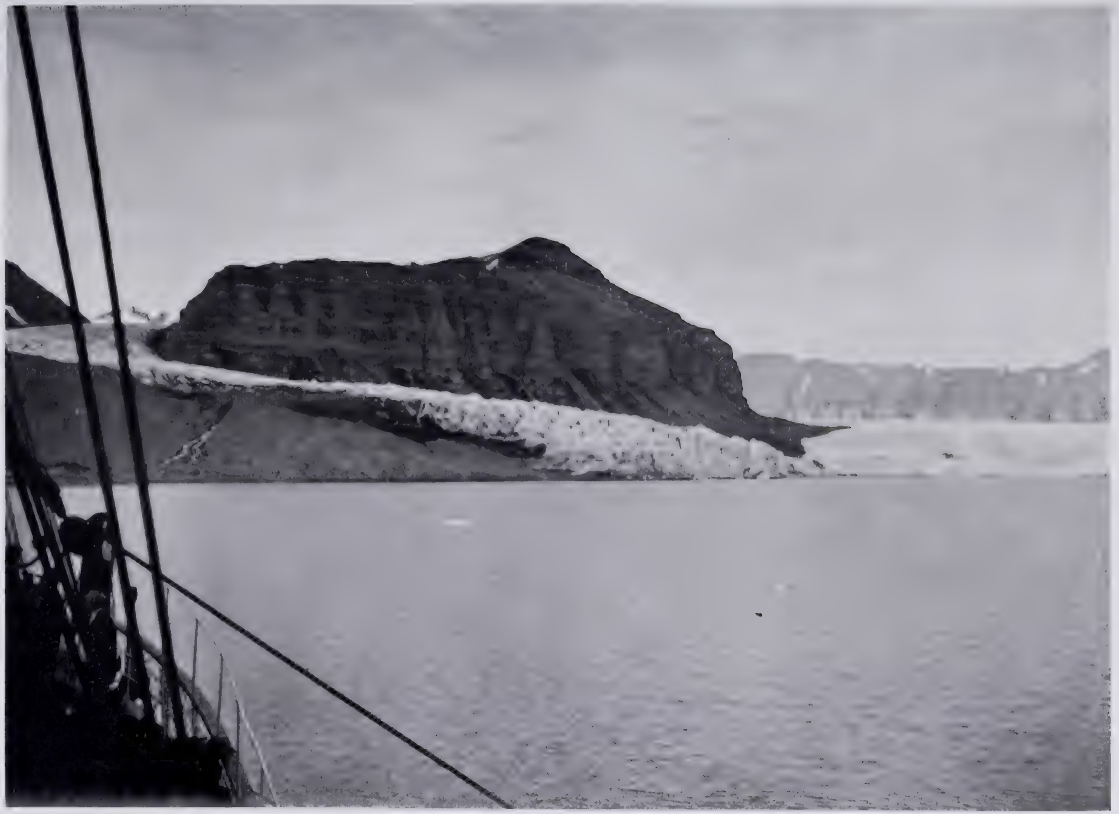
[1] Op. cit. *Quart. Journ. Geol. Soc.*, Vol. LIV. (1898), p. 203 *et seq.*



Photographed by Oscar Halldin, Stockholm.
Reproduced by permission of Prof. G. De Geer.

North end of Von Post Glacier, Temple Bay, on right, with former tributary, now separated from it, on left.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXXVI.

The general arrangement of the *lateral* moraines of the Von Post Glacier resembles in many respects that of the *terminal* moraine of the Sefström glacier; they are heaped up in a similar though narrower plexus of ridges which on the north side of the bay (where I saw them best) rise sharply above lower ground that has lain beyond reach of the glacier in its advance. The waters of the bay are deep, sinking so rapidly on the northern side that there are soundings of 200 feet within about 250 yards of the shore (*fide* Prof. De Geer's map), and it is surprising that so much of the bottom-moraine of the glacier should have been extruded above sea-level on its flanks. Apparently here, as on Cora Island, the ruling factor has been the rising slope upon which the ice impinged, in the one case laterally, in the other case frontally. In both cases the pressure of the glacier upon the slopes seems to have had the effect of squeezing upward and outward the moraine-laden layers from the lower part of the moving mass.

The ridges of boulder-clay forming the northern moraine rise to 40 or 50 feet above the sea and run parallel to the shore, or, in other words, to the former flank of the glacier. This moraine varies in width ; I noted one spot where it was not more than 60 or 70 yards across. A longitudinal hollow occupied by a pond of water intervened between it and the steep mountain-side, but was being rapidly filled by detritus from the adjacent screes-slopes and by fluvio-glacial wash brought down from the ends of two small glaciers in tributary valleys.

The corresponding moraine on the southern side of the bay is broader and higher, probably rising to over 100 feet above sea, but I had not sufficient time to gauge its dimensions or to examine its landward edge.

CONSIDERATIONS AFFECTING BRITISH DRIFTS

Most of the facts that I have reviewed in the above pages were, as already acknowledged, previously known to glacialists, particularly to those of Scandinavia ; but they deserve to be restated for the purpose of emphasizing their application to some problems of our British drifts. It remains for me to summarise the points that, in my opinion, are most instructive in this connection.

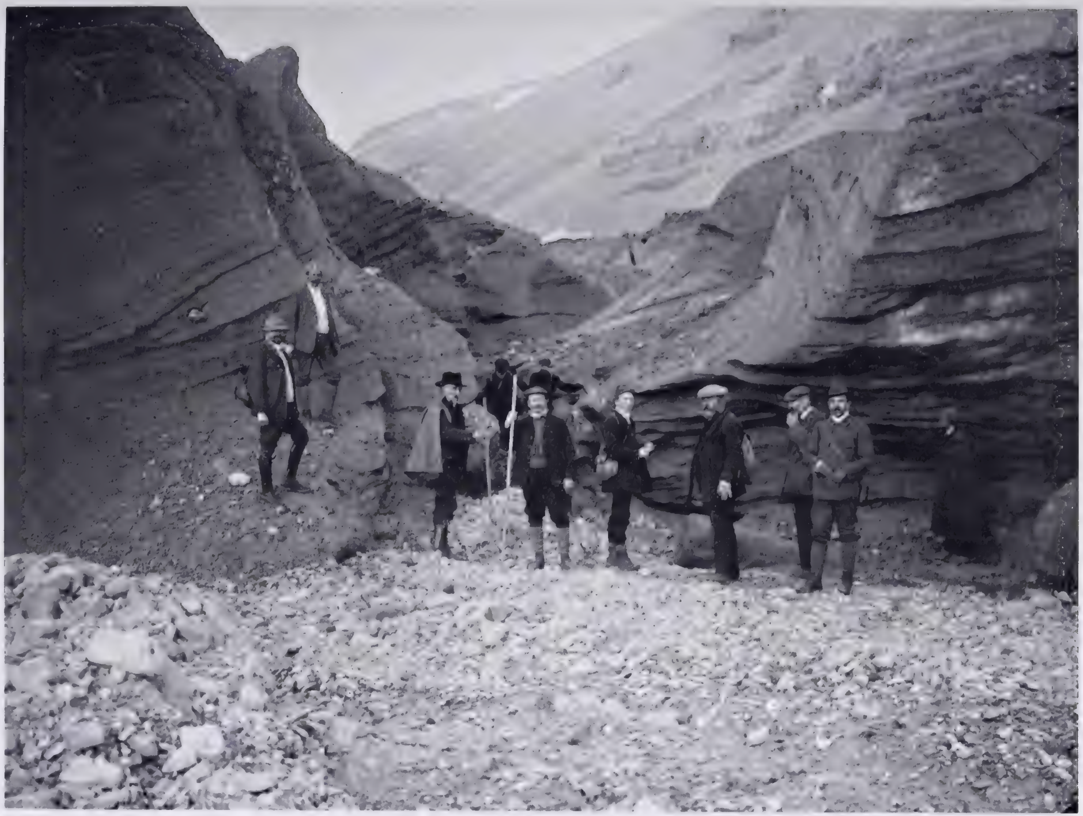
(1) There is proof of a former spread of glaciation over practically the whole of Spitsbergen ; yet, on the extensive tracts of land now bare, there is seldom any conspicuous evidence of this event, its traces on the country above present sea-level having been reduced by later erosion to remnants difficult of recognition. On the whole, there is much more drift in an equivalent area of the British Islands than is now visible in Spitsbergen.

(2) Under arctic conditions, stratified rocks similar to those covering large areas of our own country are disintegrated to a state which would favour the production of boulder-clay in quantity when the areas were invaded by moving ice. Material of this kind is seen to be readily caught up and transported by glaciers, and is discharged in huge masses at or near their ends.

(3) The moraines at and around the ends of some of the Spitsbergen glaciers bear a close resemblance in composition and structure to some of our British boulder-clays, this being particularly striking in a terminal moraine of the Sefström Glacier and in the lateral moraines of the Von Post Glacier. The red clay of these moraines is heaped up in ridges and mounds higher than neighbouring unglaciated low ground and terminates abruptly upon it. The local absence of fluvio-glacial outwash was very noticeable at the Sefström terminal moraine on Cora Island. This recalls the conditions on the eastern slope of the Yorkshire Wolds, where the red boulder-clay ends off irregularly and indefinitely upon the rising ground of bare chalk.

(4) The presence of vast numbers of shells, mostly unbroken, in the terminal moraine of the Sefström Glacier after it had crossed an arm of the sea shows how readily marine material can be hoisted up from the sea-floor and transported by an advancing sheet of land-ice. It illustrates the manner in which our shelly drifts have been spread by the ice-sheets of the Glacial period over the land surrounding our sea-basins. The admixture of certain shells not now living in Spitsbergen waters adds to the analogy.

(5) The sudden advance of the ice on Cora Island seems to have caused no interruption of the previous conditions on the ground not reached by the glacier ; which shows that the influx of land-ice need not greatly interfere with the state of adjacent land. In this latitude the flora and fauna inhabiting the land



Photographed by Oscar Halldin, Stockholm. *Reproduced by permission of Prof. G. De Geer.*

South end of Von Post Glacier ; the cliff and gully are cut in contorted ice-laden with morainic material.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXXVII.

are of the scanty arctic type ; but under similar circumstances at lower latitudes, as for example, in Alaska and Patagonia, a dense covering of vegetation is found close up to the ice-margins. It is likely that throughout the Glacial period any part of our Islands that was permanently, or even temporarily, bare of ice would be tenanted by plants and animals in a similar manner. There is much probability that the Pleistocene fauna of Britain was adapted to such conditions, and was in part contemporaneous with the waxing and waning ice-sheets.

(6) The local piling up of a mass of boulder-clay, to a thickness of 100 feet or more, by the Sefström glacier during its brief invasion of Cora Island, an invasion lasting certainly less than 10 years and probably not more than 4 or 5 years, shows how rapidly the glacial deposits may sometimes be accumulated. The conditions in this case were comparable to those of our Eastern lowlands. It is evident from this that no safe conclusion as to the duration of glaciation can be deduced from the thickness of the boulder-clay at any particular spot. We know from other evidence that the glaciation of our Islands was a slow and very lengthy process ; but it may nevertheless have happened that some of our thickest drifts in the marginal areas were accumulated during a particular phase of very short duration. The greatest amount of drift is deposited near the limits reached by the ice ; consequently, the thickness of the glacial deposits must often be in inverse ratio to the time-factor of glaciation.

NOTE.—For the photographs reproduced in illustration of this paper, I am indebted to Prof. G. De Geer, Dr. A. Strahan, F.R.S., and Prof. R. S. Tarr, who have kindly consented to this use of them. I have further to thank Prof. De Geer for permission to reproduce his map of the Sefström Glacier, and for the list of shells and much other information and advice; and Dr. Strahan for writing the description of the conditions around the glacier-remnant on Cora Island.

NOTE ON THE ZONES OF THE CARBONIFEROUS LIMESTONE SOUTH OF THE CRAVEN FAULT.

BY ALBERT WILMORE, D.SC., F.G.S.

I wish in this brief note to give some indications of progress in the investigation of the zonal sequence in the area dealt with in my previous papers. These papers have been chiefly concerned with the lithology, with a general statement of the chief fossils found in the different exposures, and with the description of certain characteristic corals. For some time past I have been at work trying to work out the zonal sequence in this most complicated area, taking as my key, of course, the well-known Avonian sequence and also comparing with other localities. The work will evidently be prolonged as the district is much disturbed. A number of misconceptions have also retarded one's progress.

It has been assumed that all the Craven Lowland area is occupied by Dr. Vaughan's Dibunophyllum zone, but this is clearly a mistake. It is probable that we have representatives of all the zones down to Z.

All the knoll limestones are not on the same horizon. The knolls of Downham and Clitheroe are much lower than those of Cracoe for example. The latter are most certainly high D, but the former are probably upper S or very low D. The great knolls of Elbolton and Swinden seem to include both S and D beds. The small exposures of white limestone at Crag Laithe and at Fogger seem to be in upper S., whilst the small patch of white limestone at Winterburn Reservoir is probably in D.1. or S.2.

Mistakes have also been made concerning the " Shales-with-Limestone " of the Survey. There has been a tendency to include them all in the Pendlesides. Those of Gill Rock near Barnoldswick, for example, where the Survey officers drew a definite line between the limestone massif and the shales-with-limestone, are well down in the sequence, lower Viséan or even Tournaisian.

The shales with thin limestones of Swinden Gill, near Hellifield, are not Pendlesides, but are probably upper C or lower S. The shales above the disturbed white limestone of Crag Laithe are much higher and are probably upper S or D. The great thickness of shales between the knolls of Worsaw and Twiston (near Downham) and the Grits, include the greater part of D and the Pendlesides.

These misconceptions having been cleared away, it would seem that the zonal sequence is, after all, a fairly normal one. There are certain local peculiarities, of course, but the *general* sequence is that of the rest of Britain and Belgium.

Zaphrentis Zone.

We may provisionally assign the lower beds of Horrocksford (Clitheroe), Brigg's Lower Quarry, the Quarry near Downham Church, Thornton Quarry and the lowest beds of Eshton Moor to this zone. After prolonged work in these beds I have been unable to find any Lithostrotion or Cyathophyllum or Clisiophyllids. I have only seen one specimen of a large Caninia and that was from Thornton Quarry (it was a badly crushed, poor specimen).

The *chief* fossils are :—

Syringopora reticulata Goldf.
Michelinia cf. favosa (Goldf).
Zaphrentis omaliusi M. E. and H. (very common).
Zaphrentis delanouei M. E. and H. (not common).
Productus cf. pustulosus Phill.
Chonetes cf. hardrensis Phill.
Leptaena cf. analoga (Phill).
Athyris cf. royssii (L'Eveillé).
Rhipidomella (Orthis) michelini (L'Eveillé).

Syringothyris Zone (C.) = Upper Tournaisian and Lower Visean.

We may provisionally assign to this zone the beds with abundant large Caninia at Swinden Gill Head, Warrel, Bell Busk Station, Crags near Bell Busk, Winterburn Chapel, Owslin Barn and Hetton. The beds of Rain Hall may possibly be C, but no large Caninia seem to occur. Caninia cornucopiae Mich. is, however, fairly common, and also in the similar beds at the bottom of the Gill Rock beds.

The *chief* fossils in these beds are—

Zaphrentis densa Carruthers } somewhat rare.
Zaphrentis ambigua ,, }
Caninia cornucopiae Mich.
Caninia cylindrica (Scouler), or gigantea Mich.
Michelinia cf. grandis or Michelinia cf. megastoma Phill.
Syringopora reticulata Goldf.
Syringopora cf. ramulosa Goldf.
Productus sublaevis de Kon.
Productus cf. pustulosus Phill.
Pr. cf. semireticulatus Mart.
Orthotetes crenistria (Phill).
Chonetes cf. papilionacea Phill.
Chonetes cf. comoides Sow.

I have found a Clisiophyllum just at the top of the beds with large Caninia at the Crags near Bell Busk. I have obtained a specimen of Lithostrotion from the material *on the floor* of the Quarry at Swinden Gill Head, where the typical Caninia gigantea or cylindrica occurs. These are the earliest occurrences of the upper corals known to me.

Seminula Zone.

To this zone may probably be assigned most of the knoll beds. of Downham and Clitheroe, the upper beds of the Crags near Bell Busk, the "Knoll" beds of Crag Laithe and Fogger, and the exposure of white limestone near Newsholme. The zone also probably includes the lower beds which occur chiefly on the northern side of Elbolton, but which are partly folded in with the upper beds in that mighty knoll, also part of the folded beds of Swinden. The beds with Carcinophyllum and Lithostrotion martini near Threapland may also be provisionally assigned to S.

Cyathophyllum c.f. murchisoni appears and becomes plentiful. Carcinophyllum and Lithostrotion are also fairly common, but Clisiophyllids other than Carcinophyllum are still relatively rare. Syringopora cf. "distans," and Syringopora cf. geniculata occur rarely, but Cladochonus seems to have replaced Syringopora for the most part. Michelinia sp. tending towards tenuisepta occurs.

Dibunophyllum Zone.

This zone probably includes most of the rich collecting ground of Elbolton and some part of Swinden Knoll, the upper beds of Cracoe, the rich coral beds of Rylstone, the upper beds of Crag Laithe, the Otterburn shales with limestone, the white limestone of Winterburn Reservoir, and the lower part of the great series of shales-with-limestones between the Downham Knolls and the grits.

Farther east, the beds at Dibbles Bridge, with Cyathophyllum regium, Lithostrotion irregulare, &c., the upper beds of Trollers Gill clearly belong to this zone. There can also be little doubt about the richly fossiliferous beds of Greenhow Hill with Lithostrotion basaltiforme, L. irregulare, " Cyclophyllum " (two or more species), Dibunophyllum and Lonsdaleia.

Some of the *commoner* fossils are :—

Cladochonus sp.
Michelinea tenuisepta (Phill).
Lithostrotion irregulare M. E. and H.
L. portlocki (Bronn.).
L. m'coyanum M. E. and H.
Cyathophyllum cf. stutchburyi ?
Caninia (or Diphyphyllum) subibicina M'Coy.
Dibunophyllum sp.
Clisiophyllum sp.
Zaphrentis amplexoides Wilmore (in the shales)
Cyathaxonia rushiana Vaughan (in the shales).
Productus giganteus (latissimus) Mart.
Pr. striatus Fischer.
Pr. edelburgensis.
Pr. martini Sow.
Schizophoria (Orthis) resupinata (*var.* connivens) (Phill.)

In the shales of S and D there are numerous caninoid or zaphrented forms which are probably mutations of Caninia cornucopiae. I think it is highly probably that the Zaphrentis amplexoides which I described from Rylstone and which I have since discovered in other exposures is one of these descendants of Caninia cornucopiae. I am working at these forms and I have much material from various exposures awaiting, study and description.*

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* In aid of this and other Coral work, the Committee of the Royal Society kindly made me a grant.

NOTES ON THE BELEMNITES OF THE YORKSHIRE CHALK.

BY J. W. STATHER, F.G.S.

In the Bulletin de la Société Géologique de France for 1899, page 129, M. A. de. Grossouvre has an interesting paper[1] on "General Observations on Belemnites and particularly those of the Corbiéres district."

In this paper the author seems to have been the first to have noticed the fact that, as the Belemnites ascend the strata, they gradually vary, both in the depth of the alveolar cavity, and in the nature of the granular surface of the guard. He points out that in the lower beds of the strata the alveolus is exceedingly shallow, and in fact hardly present at all ; as is the case in our Yorkshire and Lincolnshire examples of the well-known *Belemnitella plena*, which occurs at the base of the Middle Chalk, and can be said to have had no alveolar cavity at all, at any rate in that part which is preserved in the "Black Band."

The next in ascending order, referred to by M. Grossouvre, are the forms known as *Actinocamax westphalicus*, which have an exceedingly shallow alveolar cavity, but which, so far, has not been identified in the Yorkshire Chalk. Still higher, the author refers to *Act. granulatus*, where the alveolar cavity is obviously deepening, whilst in the upper beds of the Chalk the cavity is distinctly quadrate in section, is much deeper, and quite typical of the form of Belemnite known as *Act. quadratus*.

M. Grossouvre takes pains to point out in his paper that there is no distinct break in the sequence, but that *westphalicus* gradually merges into *granulatus*, and *granulatus* into *quadratus*, and that intermediate forms obtain which it is difficut to assign either to one species or the other.

Dr. A. W. Rowe in his well-known series of papers on the English Chalk, showed in his Dorset memoir[2] that, as in the case of France and Switzerland, "we have (in Dorset) a complete and unbroken transition from *Actinocamax westphalicus*, with its notably shallow alveolar cavity, to the deeply alveolated *Actinocamax quadratus*." Dr. Rowe had the advantage of a perusal of M. Grossouvre's paper, and was gratified at being able to confirm the observations of that writer.

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[1] Quelques Observations sur les Bélemnitelles et en particulier sur celles des Corbières.
[2] Proc. Geol. Assoc., Vol. XVII., Pt. 1, 1901.

On examining the Yorkshire Chalk, Dr. Rowe[1] was able to show that, from such specimens as he had been able to collect, the observations of M. Grossouvre and himself, in France and Dorset respectively, were confirmed. In Yorkshire, however, there was by no means the complete series available that existed in the South, and he admitted that, so far as his observations went, he had not been able to find a single unquestionable *Act. quadratus*, nor of *Act. westphalicus*, in the county. Notwithstanding his admittedly careful and detailed examination of the Yorkshire Beds, he was only able to obtain specimens from the middle of the series. So far as these went, however, they conformed with the general changes already mentioned ; namely, that in the lower beds the specimens approached *westphalicus*, in the middle beds they were distinctly of the *granulatus* type, and in the upper beds they approached *quadratus*.

On page 271 of his Yorkshire paper he gives a number of diagrams of Belemnites collected from the base of the *Micraster cor anguinum* zone at High Stacks ; the lowest in his series ; to the *quadratus* zone at Ruston Parva, which was the highest example that he obtained. The series as set out in his sketch certainly indicates that the alveolar cavity gradually deepens as specimens are obtained in ascending order, thus confirming M. Grossouvre's observations.

In 1894, Mr. G. W. Lamplugh contributed a valuable paper to these Proceedings on the Yorkshire Chalk, Part 1.[2] In this he gave measurements of every individual bed that occurs in the cliff section between Sewerby and High Stacks, which total 550 feet ; together with lithological particulars of the beds, and with sundry details as to their fossil contents. Upon this paper I have formed the basis of my own field work in the district ; and on my visits to the sections I have supplemented particulars of the various fossils, etc., found, being careful to add each individual record to the particular bed in which it occurs.

In addition to the 550 feet of flintless chalk on the coast, Mr. Lamplugh estimates that there are at least 100 feet of Upper Chalk inland which may be examined here and there in quarry sections.

My own observations tend to confirm Mr. Lamplugh's estimate, and, if anything, my impression is that he has under-estimated the extra depth of Chalk inland. In addition, I have been fortunate in obtaining a number of Belemnites from beds in which previous workers had not been successful in obtaining specimens, so that we are in a position to record a much more complete series than was hitherto possible.

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[1] Proc. Geol. Assoc., Vol. XVIII., Pt. 4, 1904.
[2] Proc. Yorks. Geol. Soc., Vol. XIII., Pt. 1.

Presumably basing his opinion on the specimens he collected, Dr. Rowe suggested that the highest beds of the Yorkshire Chalk occurred in the well-known pit at Ruston Parva which yielded the most deeply alveolated specimens he obtained. On purely stratigraphical grounds I was led to doubt this, but, fortunately, the finding of specimens in the White Hill Pit on the Scarborough Road, a mile north of Bridlington Old Town, confirmed my suppositions. The specimens which I obtained myself, as well as others since found by other workers, unquestionably have a much deeper alveolus than any hitherto recorded for the Yorkshire Chalk, and on my submitting these specimens both to Dr. Crick and Mr. C. Davies Sherborn, it was stated by both that unquestionably the examples were *Act. quadratus*, and were therefore new records for the Yorkshire Chalk.

In his paper, Dr. Rowe states he was not successful in finding any remains of Belemnites in lower beds than the flintless Chalk south-west of High Stacks ; consequently he was not able to produce any form attributable to *westphalicus*. A careful examination of the upper flinty beds north of High Stacks has recently resulted in at least two Belemnites being found. These unquestionably have the characters of *westphalicus*, and were much shallower in the alveolar cavity than any previous Yorkshire examples. They occurred well within the flint beds, and if *westphalicus* occurs in Yorkshire at all, these specimens may safely be said to be of that species.

In endeavouring to ascertain the exact stratigraphical position of the species figured by Dr. Rowe[1] some little difficulty is experienced by an amateur from the fact that he locates his various specimens from such and such a zone, whereas it is not always readily ascertainable what precise position in the Chalk these zones occupy. In working out the details of these Belemnites, I have felt that it would add value to the observations if the precise relative position of each specimen should be obtained, and by taking the first line of flint nodules at High Stacks as a

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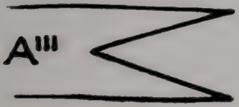
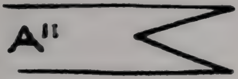
[1] loc. cit. p. 271.

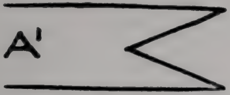
Diagram showing the actual depth of alveolars of Belemnites, in stratigraphical order, from the Upper Chalk of Yorkshire:—



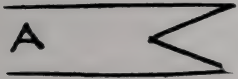
From the White Hill Quarry,
Bridlington .. .. 650′



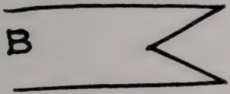
Bessingby Quarry, Brid. .. 600′



Ruston Parva Quarry .. 570′



Coast Section between—
Sewerby and Danes Dykes .. 530′



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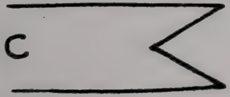

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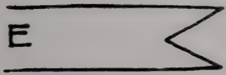

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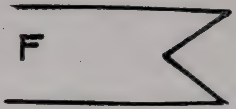
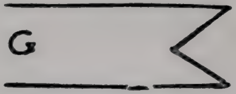
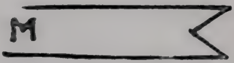


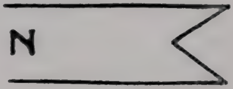
From Coast Section between—
Sewerby and Danes Dykes 400′



" " 350′



Danes Dykes and South Landing .. 150′



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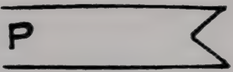
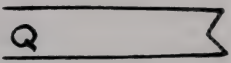
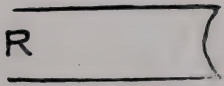


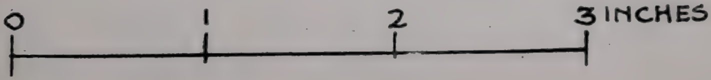
South Landing and High Stacks .. 60′



" " 20′



North of High Stacks .. ..—1′

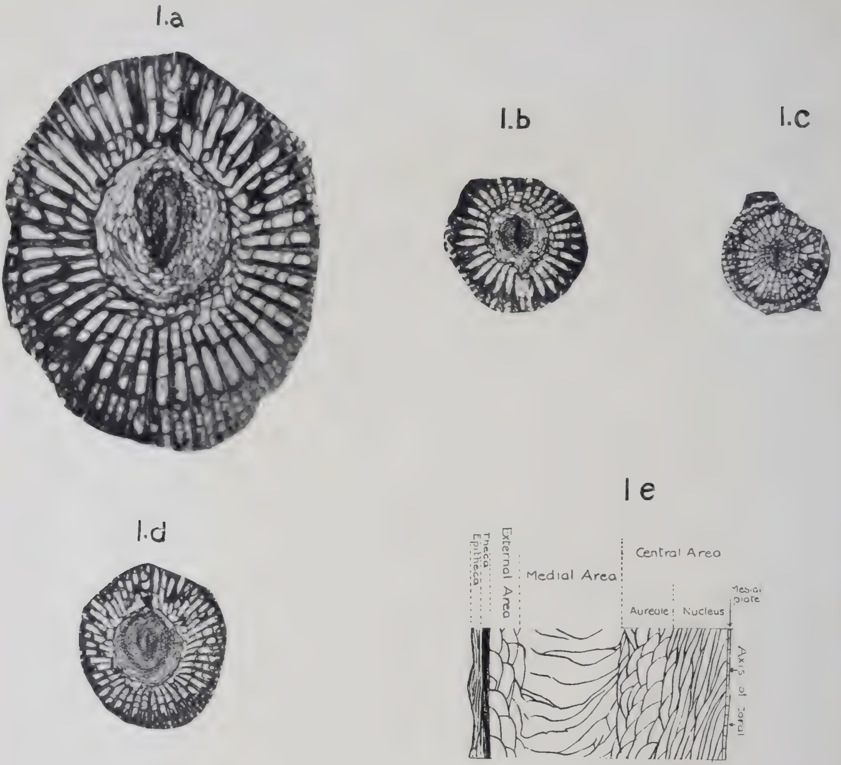


The figures indicate the height in feet, above the line of flint nodules at the base of High Stacks, except R, which is 1 foot below that line. The figures relating to A^{1}, A^{11}, A^{111} are estimated and not actual measurements.

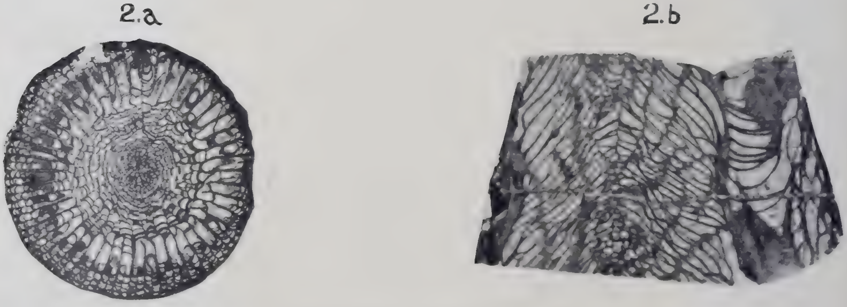
base, with the aid of Mr. Lamplugh's paper it has been possible to locate definitely the exact stratigraphical position of each specimen. In all, examples have been obtained from fourteen different horizons, as shown on the accompanying table. Thes represent, so far as is now known, a complete series from the lowes Belemnite-bearing beds (of this type) in the Upper Chalk to the highest, and without exception they all conform to the rule laid down by M. Grossouvre.

In fact, to such an extent is this the case that it is now easily possible to assign to its relative position in the series any particular specimen merely from the depth of its alveolar cavity alone.

The illustrations shown on the Diagram clearly indicate the deepening of the alveolar cavity as we examine the specimens in descending order. I am indebted to Mr. W. H. Crofts for the drawings, and also to different members of the Hull Geological Society for the loan of specimens, all of which confirmed the results arrived at by an examination of my own specimens.



Clisiophyllum ingletonense Vaughan.



Clisiophyllum omaliusi Haime.

J. W. Tutcher, Photo.

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXXVIII.

NOTE ON CLISIOPHYLLUM INGLETONENSE, SP. NOV.

BY ARTHUR VAUGHAN, M.A., D.SC., F.G.S.

By the kindness of Mr. Cosmo Johns, I was privileged to study the fossils he had obtained from "the Carboniferous Basement Beds at Ingleton," and to add a note to his account of these interesting rocks (Geol. Mag., N.S., Dec. V., Vol. III. (1906), pp. 320-323). In it I suggested that these beds were deposited in Mid-Avonian (C-S) time, a suggestion that has been fully confirmed by Mr. Johns in his subsequent work.

The object of this note is to describe the new species of *Clisiophyllum*, which is recorded in the list of fossils from the Basement Beds as "Clisiophyllid (cf. *Carcinophyllum mendipense*)" (loc. cit. p. 322).

CLISIOPHYLLUM INGLETONENSE, sp. nov. Pl. XXXVIII., figs. 1*a*–*e*.

DESCRIPTION.

External form :—

Cylindrical in adult, cornute only in young.

Epitheca smooth with annular thickenings and frequent constrictions.

Calyx deep, with sharp rim.

Columella projecting from the floor of the calyx as a tall crested spike (quite as in *Carcinophyllum*).

Horizontal section at adult stage (Figs. 1*a*, 1*d*) :—

SEPTA.

Major and minor septa project forward into the medial area and are prolonged backward to the theca ; the majors extend across the medial area, the minors merely project into that area as short spikes.

All the septa are strongly thickened at the inner wall.

A fossula is only indicated, on the concave side, by a shorter major septum.

INNER WALL.

Strongly marked out by stereoplasmic thickening.

EXTERNAL AREA.

Completely septate, moderately broad, with 5 or 6 rows of interseptal vesicles.

MEDIAL AREA.

Broad with few vesicles.

CENTRAL AREA, composed of three distinct elements :—

(1) a strongly thickened mesial plate.

(2) an inner "nucleus" of closely reticulate mesh.

(3) an outer "aureole" of broad loose mesh.

The boundary of the aureole is thickened, with the result that the central area is strongly marked off from the medial.

The lamellæ are numerous; thin within the aureole, thickened within the nucleus and, for the greater number, reaching the mesial plate. At the outer boundary of the nucleus, the lamellæ are strongly thickened and short additional lamellæ are intercalated, thus increasing the fineness of the reticulation within the nucleus.

The concentric intersections within the nucleus are very closely set and cross many lamellæ with continuous curvature—indicating tabulæ without discontinuities.

Within the aureole, however, the concentric intersections " jump " in passing a lamella—indicating inter-lamellar vesicles.

[Within the nucleus of most fully grown specimens, there is a second zone at which the lamellæ are thickened and short intermediates intercalated (see Fig. 1*d*.).]

The mesial plate has always a well-marked primitive streak and is exceptionally thickened ; the ends of the lamellæ are firmly attached to it, producing the peculiar " centipede " appearance (characteristic also of *Carcinophyllum*).

Horizontal section at earlier stages (Figs. 1*b*, 1*c*) :—

The inner wall is very thick and formed by root-like outgrowths from the major septa ; the minor septa are almost embedded in the junction of these processes.

The external area is very narrow, but essentially septate, although here and there the septa are discontinuous.

Within the central area, the lamellæ are close-set, thick and irregular, but firmly attached to the mesial plate.

In the youngest stage figured (Fig. 1*c*), there is no aureole ; consequently the central area is typically Carcinophylloid, and this resemblance is heightened by the presence of 30 thick septa.

Fig. 1*b* shows a later stage in which the aureole has been developed.

Vertical section at adult stage (Fig. 1*e*) :—

The epitheca is composed of thin wavy vertical layers ; lacunæ are frequently developed within the thickness of the epitheca, and especially at its junction with the theca.

The theca is a thick solid band, minutely prismatic.

The external area is composed of several rows of vesicles elongated vertically.

The medial area contains broad distant concave tabular vesicles which lie more or less horizontally.

The aureole of the central area is mainly built-up of layers of vesicles which dip steeply outwards.

The nucleus shows close-set, steeply-peaked vaults, one within and under the other as in a *Carcinophyllum*.

The mesial plate is continuous from base to summit.

GENERIC CLASSIFICATION.

I. Comparison with *Carcinophyllum* Thomson.

As a typical species of *Carcinophyllum*, I select *C. mendipense*, Sibly (Q.J.G.S., Vol. 62 (1906), p. 369 and Pl. 31, Fig. 4); this species is well known to me, and appears to agree in generic characters with the geno-type—*C. kirsopianum* Thoms. (Proc. Phil. Soc., Glasgow, Vol. XIV. (1883), Pl. XII., Fig. 9*a*).

Our species agrees with *Carcinophyllum* in structure of nucleus and mesial plate, as well as in the thickened septa and inner wall.

It differs in having a septate external area and an aureole.

II. Comparison with *Clisiophyllum* Dana.

As a typical species of *Clisiophyllum*, I select *C. omaliusi* Haime, figured in this paper (Pl. XXXVIII., Figs. 2*a*, 2*b*); this species agrees with the definition given by Dana in "Narr. U.S. Explor. Exped.," 1838-42, Vol. VII., Zoophytes, p. 355, and pp. 361, 362.

Our species agrees with *Clisiophyllum* in the large reticulate central area and in the septate external area.

It differs in having a strong mesial plate[1] and well marked boundary walls between the several areas.

CONCLUSIONS.

Clisiophyllum ingletonense may therefore be said to be a *Clisiophyllum* with strong convergence toward *Carcinophyllum*, particularly in the young stages.

It belongs to a sub-division, the nucleated *Clisiophylla*, characterised by the differentiation of the central area into nucleus and aureole; this group is, however, probably diphyletic (*vide* infra.).

Nucleated *Clisiophylla* already figured

from the base of the Viséan (C–S).

S_1, Blackstone Point (near Arnside); figured by Prof. E. J. Garwood in Q.J.G.S.[2]

This form is very near our species, certain specimens being identical.

S_1, Carlyan Rocks, Rush (Co. Dublin); figured by myself in Q.J.G.S., Vol. 64, Pl. 49, Fig. 1.

Differences: the aureole is indistinctly marked off from the medial area.

S_1, Vallis Vale, E. Mendips; figured by Dr. T. F. Sibly in Q.J.G.S., Vol. 62, Pl. 31, Fig. 5*a*.

Differences:—The external area is Cyathophylloid and the aureole indistinctly marked off from the medial area.

Evolution of the nucleated *Clisiophylla*.

From *Clisiophyllum omaliusi* (described below), it is easy to imagine the derivation of the Cyathophylloid *Clisiophyllum* described by Dr. Sibly from S_1 of the Mendips (v. s.), for continued variation along the initiated direction would result in further differentiation of areas.

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[1] In *Clisiophyllum* the cardinal lamella is, however, usually produced across the centre and somewhat thickened.

[2] Paper read but not yet published.

Bearing in mind, however, the Carcinophylloid character of the young stage of *Clisiophyllum ingletonense*, we must look in another direction for the ancestor of our species.

It would seem justifiable to search for an early Carboniferous coral having the following characters :—

Thick septa and inner wall, thick mesial plate, the beginnings of lamellæ, and a narrow peripheral zone of broad vesicles.

As yet we are not acquainted with such a form, although the *Clisiophyllum* from γ of Burrington Combe (N. Mendips), figured in Q.J.G.S., Vol. 68, Plate 31, Fig. 3, seems to take us back a certain distance along the right line.

Of the descendants of this group of *Clisiophylla*, we have several instances in Dy (Yoredalian), but connecting links are at present wanting and we must await their discovery.

APPENDIX.

Clisiophyllum omaliusi Haime. Plate XXXVIII. Figs. *2a*, *2b*.

This species satisfies the definition of *Clisiophyllum* given by Dana and is, for that reason, introduced here.

C. omaliusi is extremely abundant in the Avesnes Area (N.E. France) where it occurs in the " Zone d'Etrœungt "—a limestone series correlated by L'Abbé A. Carpentier with the *Modiola*-beds at the base of K in the Bristol Area (Ann. Soc. Géol. du Nord, Vol. 37 (1908), p. 33). Prof. Jules Gosselet had previously figured an external view of this coral (Esquisse Géol. du Nord de la France, Fascicle 1 (1880), Lille, Pl. V., Fig. 16) and assigned the beds in which it occurs to the top of the Famennian. In my opinion, these beds should, more probably, be assigned to K_2 (Rep. Brit. Assoc. 1909, Winnipeg).

NOTES ON THE SPECIES.

Horizontal section, Fig. *2a*.

CENTRAL AREA.

This area is large, well bounded, reticulate, and traversed completely by fine close-set radial lamellæ, equal in number to the major septa and, in many cases, clearly continuous with them across the dividing line between the medial and central areas. The regular concentric intersections are more and more closely approximated towards the centre, their continuity across lamellæ indicating that the tabulæ have few discontinuities.

The differentiation of an inner nucleus is adumbrated by increased thickening and by the occasional introduction of intercalated lamellæ.

There is no true mesial plate, but the cardinal lamella is continued across the centre and slightly thickened there.

EXTERNAL AREA.

This area is typically Cyathophylloid in aspect, completely septate, without considerable thickening of the inner wall, and packed with small interseptal vesicles.

Vertical section, Fig. 2*b*.

CENTRAL AREA.

A thin mesial plate is suggested, but is discontinuous.

There is no differentiation of nucleus and aureole.[1] The whole area is traversed by close-set vaulted tabulæ, undeflected by the lateral lamellæ, but slightly ridged where they cross the medial lamella.

The boundary of central and medial areas is strongly marked owing to the vertical descent of the tabulæ.

MEDIAL AREA :—

Traversed by concave, horizontal tabulæ which are obviously continuous with those of the central area.

EXTERNAL AREA :—

Composed of several rows of vesicles, which are elongated vertically.

ANCESTORS OF THE SPECIES.

C. omaliusi exhibits such marked Cyathophylloid characters, that it is unnecessary to look further than to *Cyathophyllum* for its origin.

In the coronate group of Devonian Cyathophylla (*C. helianthoides* and its kin), the tabulæ are raised centrally and the inner portions of the long septa differentiated by thickening. Steeper upraising of the tabulæ, so that they descend vertically on all sides, would result in the strong differentiation of central and medial areas which is characteristic of the genus *Clisiophyllum*.

EXPLANATION OF PLATE.

Fig. 1.—*Clisiophyllum ingletonense* sp. nov.

Basement Beds of the Carboniferous Limestone C_2–S_1, Ingleton (N.W. Yorkshire).

Fig. 1*a*.—Horizontal section at adult stage ; × 2½.

Fig. 1*b*.— „ „ at earlier stage ; × 1¼.

Fig. 1*c*.— „ „ at young stage ; × 1¼.

Fig. 1*d*.— „ „ of a variant, showing distinct double nucleation ; × 1¼.

Fig. 1*e*.—Diagrammatic representation of one-half of a vertical section ; × 2½.

Fig. 2.—*Clisiophyllum omaliusi* Haime.

Zone d'Etrœungt (K_2). Transition Beds from Devonian into Carboniferous. Avesnes (N.E. France).

Fig. 2*a*.—Horizontal section at adult stage ; × 1¼.

Fig. 2*b*.—Vertical section (incomplete on left hand side) same specimen ; × 2½.

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[1] *Clisiophyllum kayseri* described by Frech from the Uppermost Devonian of Velbert im Bergischer (Zeitschr. Deutsch. Geol. gesellsch., Vol. 37 (1885), p. 92, Pl. 8, figs. 2, 2a) has a very similar horizontal section (but showing, apparently, no trace of nucleus), whereas the vertical section has an aureole of broad descending vesicles and a nucleus composed of flattened-arches, one within and under another.

In Memoriam.

THE REV. E. MAULE COLE, M.A., F.G.S.

It is with deep regret that we have to place on record the death of the Rev. E. Maule Cole, the Vicar of Wetwang on the Wolds. For many years he has been a keen supporter of this Society in its work, and was ever ready to help us on our excursions, or at our indoor meetings. During the past half century he had made himself familiar with the East Yorkshire, and rarely was an excursion taken in his neighbourhood during that time but he was present, and enlivened the proceedings with his jokes and stories. In recent years his flowing white hair and beard and tall figure gave him a fine appearance, and he was usually to be seen at the head of his party ; he always insisted on a leader *leading* a party, and not bringing up the rear !

Mr. Maule Cole was a native of Dover, where he was born in 1833 ; he came to Wetwang in 1865, and from that time to the day of his death he took an intelligent interest in the Geology, Archæology and Natural History of the District in which he found himself situated. He took a pride in conducting parties over the Wolds, and for every quarry, field, hill and dale, nay, for every mound and earth-work, he had a fascinating story. Mr. Cole was a voluminous writer, and in addition to the papers appearing in our own Proceedings, he contributed to the Transactions of the East Riding Antiquarian Society, and other similar societies, and also to *The Naturalist*, *The Antiquary*, etc. In 1883 he wrote a small handbook entitled *Geological Rambles in Yorkshire*, which was followed in 1886 by an account of the Geology of the Hull and Barnsley Railway.

Notwithstanding his facile pen, Mr. Cole will probably be best remembered for the charming way in which he popularised science. He was in great demand as a lecturer, and was usually able to give a very interesting exposition on almost any subject ; and in this way was a great help, especially to beginners. He probably did more in this direction than we have any record of,

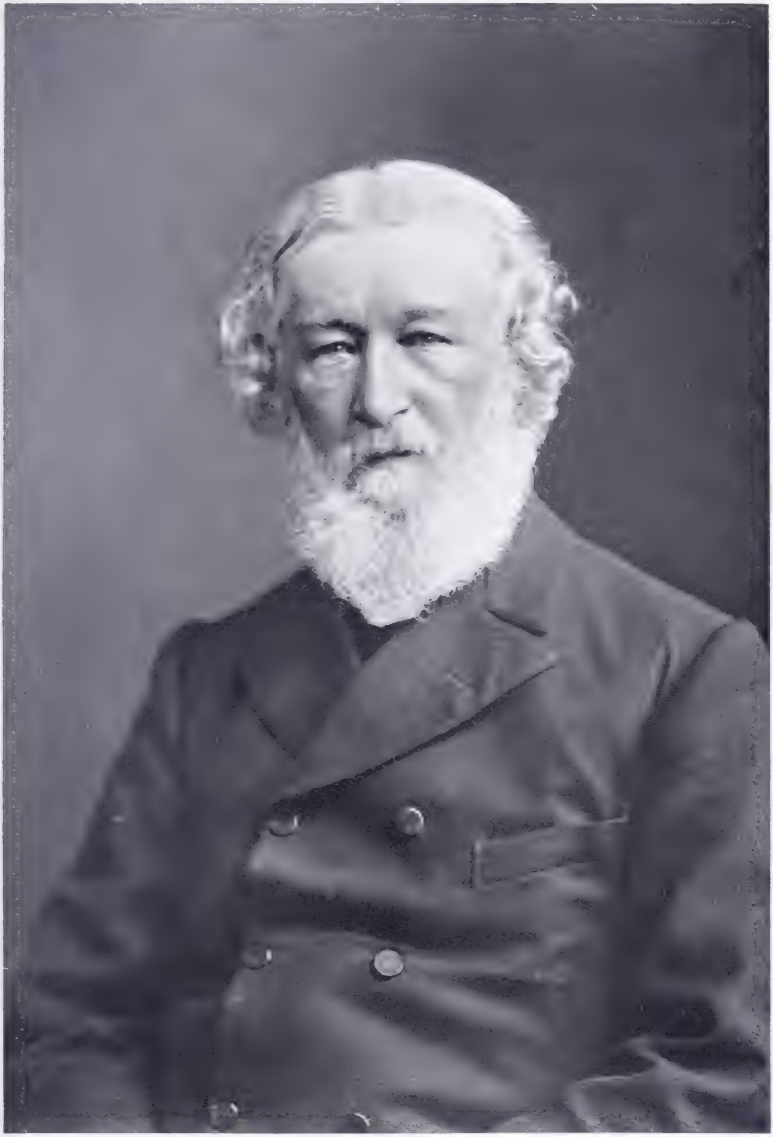

Photo. Maull & Fox 187, Piccadilly, W.

E Maule Cole

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XXXIX.

and the good he did by encouraging young workers can probably never be estimated. An account of the Rev. E. Maude Cole, with a list of his papers appeared in *The Naturalist* for August, 1907.

His papers were usually on antiquarian subjects, many such being in our own Proceedings. In addition to his two small handbooks already referred to, the following geological items are to his credit :—

The Red Chalk	Proc. Yorks. Geol. Soc.		1878
The Origin and Formation of the Wold Dales	,,	,,	1879
The White Chalk of Yorkshire	,,	,,	1882
Sections at Cave and Drewton	,,	,,	1885
The Physical Geography and Geology of the East Riding	,,	,,	1886
The Parallel Roads of Glen Gloy	,,	,,	1886
Dry Valleys in the Chalk ..	,,	,,	1887
Geology of the Driffield to Market Weighton Railway	,,	,,	1890
The Boulder Clay Cliffs of Filey	,,	,,	1894
Distribution of Moors near York	,,	,,	1899

His other Geological papers include "Waterspouts on the Wolds" (Trans. Hull Sci. and Field Nat. Club, 1901) ; "A Peat Deposit at Filey," *Naturalist*, 1891 ; "Report on a Yorkshire Coast Erosion," *Naturalist*, 1892 ; "In Memoriam, Robert Mortimer," *Naturalist*, 1892 ; "The recent Cloud-Burst on the Yorkshire Wolds," *Naturalist*, 1910 ; "Geology of Flamborough" (in *Flamborough Village and Headland*) ; and "Geology of Scarborough" (in Marshall's *Guide to Scarborough*).

T. S.

In Memoriam.

JOHN ROBERT MORTIMER.

(1825-1911).

As one grows older, there comes with sad recurrence the painful duty of recording the life's work of senior comrades who have dropped from the ranks. The death of John Robert Mortimer has deprived us of a striking personality long familiar to all scientific workers in East Yorkshire. He joined our roll in 1878 and remained a member for 30 years, contributing fourteen papers to our Proceedings—two on geological subjects, and the others, archæological. The titles of these papers will be found in the full list of his writings, appended to the sketch of his career published by Mr. T. Sheppard in *The Naturalist*, No. 652, May, 1911.

Mortimer was born in 1825 at the Wold village of Fimber, and attained his manhood there, receiving his schooling at the adjacent village of Fridaythorpe. After establishing himself in business as a corn merchant (later as a maltster also), he changed his residence to the neighbouring town of Driffield, where the rest of his life was spent, and where he died on August 19th, 1911, at the ripe age of 86 years. In 1869 he married the fourth daughter of the Rev. T. Mitchell, Vicar of Sancton and Holme-on-the-Wolds. He survived his wife by six years, and leaves a family of three sons and two daughters.

Mortimer had a deep affection for his native place and its surroundings, and his scientific interests were local, in the best sense of the word. Everything that pertained to the past history of the district around his home was of the keenest interest to him, and his great anthropological and geological collections were brought together almost entirely from the short radius of Wold country that served him throughout life as a happy hunting ground.

Yours truly
J. R. Mortimer

Proc. Yorks. Geol. Soc., Vol. XVII., Plate XL.

It is indeed the peculiar value of his scientific work, that it has dealt so exhaustively with a definite and limited tract ; his collections remain as a splendid example of what, with persistent effort, may be achieved for science in the spare hours of a strenuous business career. To the end of his days, Mortimer found relaxation and delight in his studies, and I know that they served him well as a solace in times of strain and stress.

Mortimer was delicate of health during his youth, and in later years he was never robust ; but his tall lithe frame, his alert movements, and his bright eyes betokened the tough virility and mental energy that carried him through a long life and remained in him unabated almost to the last.

He was fond of telling how his interest in science was first stirred by an eventful visit to the Great Exhibition in London in 1851. Then he began to collect the flint implements of the Wolds, aided by his brother, the late Robert Mortimer, who joined keenly in the search. This soon led him to the opening of barrows and the excavation of earth-works ; and, having once begun, he carried on the work with his wonted tenacity of purpose, throughout the whole district, as opportunity occurred, for over forty years. To store and display the huge collection thus gathered he built a private museum at Driffield, cherishing the hope that this would remain as a permanent memorial of his researches. Late in life he set himself the arduous task of publishing a full record of his archæological findings, and, with the aid of his daughter, Agnes, who prepared all the drawings, and of his friend, Mr. T. Sheppard, who undertook the editorial duty, this task also was brought to a successful conclusion by the publication six years ago of a monumental volume entitled "Forty Years' Researches in British and Saxon Burial Mounds of East Yorkshire" (pp. 86 + 452, and 125 plates. A. Brown and Sons, London and Hull). When this great work issued from the press, its author had already attained the age of 80 years ; yet after that, he further published seven or eight papers, the last, on "The Stature, etc., of our Ancestors in East Yorkshire," being sent for reading at the Portsmouth (1911) Meeting of the British Association ; but his life ceased just before the meeting. We learn from Mr. Sheppard's account in *The Naturalist* that there are also several more papers written, but not yet published.

During the middle years of his life, Mortimer regularly attended the meetings of the British Association, with a little group of Driffield friends interested in science, of whom he was the last survivor. I remember well how, almost at the beginning of our acquaintanceship, we were together at the famous Jubilee Meeting of the Association at York in 1881; and he was again present, for the last time, at the same place of meeting in 1906. Until the later years, he came to most of the East Riding meetings of our own Society; and he was for many years the moving spirit in a Driffield Literary and Scientific Club, now defunct.

In spite of his long business experience, Mortimer never was able to master a constitutional diffidence which hampered him at public meetings, though only those intimate with him could realize how much he was affected by this deterrent. When at his ease, among friends, he showed a fund of charming light-heartedness, whimsical humour and quaint speculation which made his companionship always delightful. His reminiscences of old village customs and of his boyhood on the Wolds were singularly vivid and full of interest for the student of folk-lore. In his youth he had a strong taste for mechanics and for astronomy; and he always possessed a natural deftness and skill in fine handicraft, while his versatility in many other directions increased with years and never flagged. His kindly sympathetic disposition and native shrewdness were characteristics appreciable by all his acquaintances; his rarer qualities were revealed perhaps only to those who knew him best. His work as an archæologist of the 'good old school' ensures that the memory of him will not be forgotten.

G. W. Lamplugh.

[For Mr. Mortimer's photograph we are indebted to the kindness of the Editor of *The Naturalist*, to whom we tender our thanks. Ed.]

ANNUAL REPORT FOR 1911.

The interest of the members in the affairs of the Society has not diminished, and another good year's work can be recorded. The publications of the Society continue to maintain their high standard. In addition to the part of the Proceedings which is issued annually the Council decided to undertake the publication of the Bibliography of Yorkshire Geology by the late Mr. Fox-Strangways. They were fortunate in enlisting the services, as special Editor, of Mr. T. Sheppard, who has undertaken to make the necessary additions and to complete the work up to the end of 1911. It is hoped to issue the volume early in 1912. The membership of the Society shows a slight decrease, but it still stands at the satisfactory figure of 198.

The opening Meeting and Excursion was held in Leeds on Thursday, March 9th. The morning Excursion was conducted to the Roundwood Colliery (near Wakefield) to examine the variations in the Cannel Seam, and was well attended. The General Meeting was held in the Hotel Metropole, Leeds, at 7.0 p.m., under the presidency of Prof. P. F. Kendall. After the transaction of the formal business, a paper on "The Shelly Moraine of the Sefström Glacier and other Spitzbergen Phenomena illustrative of British Glacial Conditions" was read by Mr. G. W. Lamplugh, F.R.S., F.G.S. The paper was followed by an animated discussion. A paper "On the Thickness of the Carboniferous Limestone South of the Craven Faults" was then read by Dr. A. Wilmore, F.G.S., and afterwards discussed. Both papers have been published in the Proceedings.

The Easter Meeting and Excursion was held in Scarborough, and attracted a large attendance. On the Friday, a large party left Scarborough by the Seamer Road for Peacock's Quarry (Cornbrash), Stone Haggs Quarry (Lower Calcareous Grit) amd then along the old road to other quarries in the Coralline Oolite and Coral Rag, returning viâ Deepdale and Oliver's Mount.

On Saturday, Cloughton was visited, and an examination of the Plant Bed and other fossiliferous sections at the Wyke, and the Grey Limestone at Hundale Point was made. The General Meeting was held in the Pavilion Hotel, Scarborough, the headquarters during the meeting, Mr. G. W. Lamplugh taking the chair in the unavoidable absence of the President. The chairman introduced a discussion on the Oolitic Rocks of the district, and also gave an account of work done in correlating some deep borings in Kent, which indicated movements during the deposition of the rocks and suggested that similar observations might be made on the Yorkshire coast. Mr. Drake mentioned the *Unio* band in the Estuarine Beds near Scalby, and exhibited a fine suite of Cornbrash ammonites. Mr. H. Preston gave particulars of a boring which had recently been completed at Derwentdale in the Vale of Pickering. On Monday an excursion was made to Suffield and Hackness to see the interesting sections in the Coralline series, and after visiting the Hutton Bushall *delta* a call was made at the famous Ayton Quarries in the Coral Rag. The low tide on Tuesday morning was taken advantage of by many members to examine the coast sections south of Scarborough. Messrs. Stather, Sheppard and H. C. Drake were the leaders of the excursions.

The June Excursion was held at Ingleton, the headquarters being the Ingleborough Hotel. Professor Kendall was the leader. The main objects of the meeting were (1) To examine the Permian Rocks of the Ingleton Coalfield and review the evidence they afford of the two stages of movement which resulted in the denudation of the Ingleton fault-block. There are good sections available in the Permian rocks which include Lower and Upper Breccias. In the Lower Breccia pebbles of Spirobis Limestone, like those of the highest Coal Measures of the Manchester district, have been found, but only one specimen of Carboniferous Limestone is recorded. In the Upper Breccia on the other hand no Spirobis Limestone has been found, but instead large quantities of Carboniferous Limestone, some Millstone Grit and many fragments of Silurian slate. (2) To examine the fine exposure of Viséan Limestone in the Meals Bank Quarry. Near the top of the S_2 sub-zone is a small coal seam with a seat earth with rootlets, resting on an irregular surface of limestone. (3) To study the origin of the outlet of Kingsdale. The broad flat floor of the Dale with its gorge-like outlet suggests its occupation by the waters of a lake. At the General Meeting held on June 16th, the President gave an interesting address on the Coal Measure and Permian Rocks of the neighbourhood with special reference to the age of the Craven Faults.

A Meeting, and excursions, was held in Hull, September 28th and 29th. The leaders were Messrs. Stather and Sheppard. On the Friday an excursion was made to Withernsea to examine the fine coast section of the Glacial Deposits. The General Meeting was held the same evening in the Grosvenor Hotel, when, owing to the unavoidable absence of the President, the chair was occupied by Mr. Wm. Whitaker, F.R.S. A paper on "The Origin of Blow Wells," by the President, was read in the absence of the author, by Mr. Sheppard. The discussion which followed was taken part in by the Chairman and Messrs. Stather, Walton, Thompson, Sheppard, Crofts and Sewell. Mr. J. W. Stather then read a paper on "Some Cretaceous Belemnites," illustrated with a number of specimens and diagrams. The chairman and Messrs. Walton, Thompson, Sheppard and Johns took part in the discussion which followed. Votes of condolence with the relatives of the late Mr. J. R. Mortimer, Rev. E. Maule Cole and Mr. J. Ackroyd in their respective bereavements, and of sympathy with Mr. Godfrey Bingley in his illness, were passed. On Saturday, despite the inclement weather, a numerous party crossed the Humber to Barton and proceeded to South Ferriby, first visiting the fine quarries in the Middle and Lower Chalk. On the foreshore, near South Ferriby Hall, the recently exposed bed of dark clay which has furnished fossils of a Neocomian type was seen. The opinion was expressed that the importance of the exposure warranted excavations being made with a view to obtaining decisive palæontological evidence.

The Council have accepted with deep regret the resignation of Mr. W. Simpson, who for six years has been Hon. Treasurer, and they desire to record their high appreciation of his most valuable services in bringing the finances of the Society to their present flourishing state.

The Council are arranging for the following General Meetings and Excursions to be held in 1912 :—

Spring Meeting - Leeds, with morning Excursion.
Easter ,, - Appleby.
June ,, - Robin Hood's Bay.
September ,, - Ripon and Masham.

C. J.

THE YORKSHIRE GEOLOGICAL SOCIETY.

Statement of Receipts and Expenditure from October 31st, 1910, to October 31st, 1911.

REVENUE ACCOUNT.

Dr.

1910.	Receipts.	£	s.	d.
Nov. 10	To Balance from last year	21	9	5
	,, Members' Annual Subscriptions ..	82	11	0
	,, Members' Arrears Received ..	7	16	0
	,, Interest on Mortgage Bonds of Halifax Corporation	12	3	10
	,, Received for Authors' Reprints ..	3	19	0
	,, Sales of Proceedings	1	10	6
	,, Income Tax recovered	1	10	4
		£131	0	1

Cr.

1911.	Expenditure.	£	s.	d.	£	s.	d.
	By Expenses of Meetings, per Hon. Secretaries :—						
	Leeds, Nov. 18th, 1910	1	5	6			
	Leeds, Mar. 17th, 1911	1	5	6			
	Scarborough and Ingleton ..	4	17	1			
					7	8	1
	,, Postages and Sundries, per—						
	Hon. Secretary ..	0	17	6			
	Hon. Librarian ..	0	8	4			
	Hon. Editor ..	0	10	7			
	Hon. Treasurer ..	1	9	5			
					3	5	10
	,, Proceedings :—						
	A. H. Searle ..	19	5	0			
	André & Sleigh, Ltd.	15	12	3			
	Maull & Fox ..	0	10	6			
	Jowett & Sowry ..	29	14	4			
					65	2	1
	,, Circulars, Stationery, etc :—						
	Chorley & Pickersgill Ltd.	12	12	1			
	Geo. A. Jennings ..	0	3	0			
					12	15	1
	,, Cheque Book				0	2	6
Oct. 31	,, Balance in Bank				42	6	6
					£131	0	1

CAPITAL ACCOUNT.

1911.		£	s.	d.
Oct. 31	To Halifax Corporation Mortgage Bonds	370	0	0
	,, To Books, Proceedings, Maps, &c., at the Leeds University (as per Agreement dated 20th November, 1907, in the custody of the West Yorkshire Bank, Ltd.)			
		£370	0	0

1910.		£	s.	d.
Oct. 31	By Halifax Corporation Mortgage Bonds	370	0	0
		£370	0	0

Leeds, November 1st, 1911.

Examined and found correct, F. W. BRANSON, *Hon. Auditor.*

WILLIAM SIMPSON,
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*** It is requested that any Member changing his residence will communicate at once with the Hon. Secretary.

T.P.I.&K.

PROCEEDINGS

OF THE

Yorkshire Geological Society.

NEW SERIES, VOL. XVII., PART I., PAGES 1—96, AND
LIST OF MEMBERS.

With Two Plates.

Edited by ARTHUR R. DWERRYHOUSE, D.Sc., F.G.S

1909.

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Issued May 19th, 1910.

Yorkshire Geological Society.

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Yorkshire Geological Society.

OBJECTS.

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1910.

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